THE

ELECTRICAL REVIEW.

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ELECTRICITY IN AERONAUTICS.

WHILST it is satisfactory to learn that Mr. Maxim, whose attempts to solve the problem of aerial navigation have justly excited the most unqualified admiration, has no intention of abandoning his researches, we may perhaps be excused for regretting that his proposals for future investigation appear to be of the same order as the abortive operations recently conducted at Baldwyn's Park. Mr. Maxim will probably differ from us in describing these operations as abortive; for has not Lord Rayleigh stated at the late British Association gathering that of the five problems to be solved in order to make a successful flying machine, three have already been solved? Lord Rayleigh may be right; but the memory recalls another statement which this noble physicist also made at Oxford, and suggests the old logical maxim: *Ab actu ad posse valet consecutio.* [When a thing has once happened, it is reasonable to infer that it may occur again.]

Inventors, from Letur and De Bacqueville to the present day, have kept in view all along the getting into the air as their main object, losing sight of the fact that when they get there their troubles are only beginning. Here, again, we shall probably find ourselves at variance with Mr. Maxim, whose recent utterances indicate his belief that it will all be plain sailing when once he has mounted beyond the reach of eddies caused by local surface currents, due to the existence of trees and houses. The turmoil and rapid change of form which can frequently be observed going on amongst the clouds certainly suggests an opposite conclusion. We wonder whether he has read a paper by Mr. Richard Inwards, F.R.A.S., on "Some Phenomena of the Upper Air"? [*Vide Quarterly Journal of the Royal Meteorological Society*, 1894, Vol. xx., No. 91, pp. 199—214.]

For ourselves, we find our views coincident with those of the simple folk who hold that next to nothing is known of aerodynamics, and that the laws which control the movements of bodies in mid-air are not even remotely understood. These must surely be formulated before much progress can be expected in aerial navigation. True, history shows that something may be learned by mere tentative efforts; and we shall probably be reminded that ships were successfully floated and steered before the laws which govern these operations were demonstrated. The case, however, is different with an air-ship; and an unsuccessful experiment fails to teach the one who makes it, because it usually results in his material effacement. Even Mr. Maxim has to "thank his stars" that chance saved him from the fate of Icarus.

We believe in the possibility of human flight; for apart from such evidence as Mr. Maxim's and Herr Lilventhal's experiments afford, to say nothing of others who have essayed to fly, there is Prof. Langley's book on the subject. This

eminent investigator gives it as his deliberate opinion that "mechanical sustentation of heavy bodies in the air, combined with very great speeds, is not only possible, but within the reach of the mechanical means we actually possess; and that while these (his) researches are not meant to demonstrate the art of guiding such heavy bodies in flight, they do show that we have now the power to sustain and propel them."

The principles upon which Mr. Maxim has hitherto constructed the motive portions of his aerial machines, and to which he still appears to cling, evidently demand that immediate personal supervision should be given. The inventor must entrust his own, or, preferably, some other fellow's *corpus vile*, to the tender mercies of the apparatus, so that the right thing may be done at the precise psychological moment. And this, we submit, is regrettable. There are plenty of "inventors" whom the world would observe with serene interest "hoist on their own petard"; but Mr. Maxim is not one of these. The simple mind of an electrical engineer naturally concludes that since failure and grave personal risk has hitherto attended the exploitation of Mr. Maxim's ideas, an attempt with electric motors should be made. In this case the element of personal danger could be practically eliminated, for the trials of the aerial machine would be made without the necessity of an operator being actually on it. Cables, capable of being rapidly paid out, would supply the current to the motors, and the whole machine could be actuated and directed at a safe distance by electrical means.

The use of electric motors is of comparatively recent date, yet such results have already been attained as to suggest that there is at least as much likelihood of placing upon a flying machine horse-power per unit weight, supplied electrically equal to anything that can be obtained by other means. We have no sympathy with the unbalanced enthusiasm of some of our foreign contemporaries, or we might be tempted to claim considerably more than this modest possibility. Did not Mons. G. Trouvé construct last year an electric motor which developed energy at the rate of 1 H.P. for each 7 lbs. weight? The electric motor is a mere baby in experience compared with the steam engine, yet the latter is already being compelled to "look to its laurels." Not only is it possible that the electric motor may be the means of giving the large horse-power per unit of weight, which is claimed to be a *sine quâ non* in aerial navigation, but, from what it has already achieved, it is reasonable to anticipate that it will—and that very shortly. We have almost reached the limits which govern the employment of steam; but of those which relate to electricity we know very little indeed.

Our views with regard to the use of electric motors in aeronautics were clearly defined in the issue of the ELECTRICAL REVIEW for March 23rd, p. 325. We are still of opinion that the application of electricity holds out the most promising prospects of good result. And although an apparatus operated by this means might not become an independent flying machine for some time, it might be so manipulated that it would plainly indicate the real requirements for successful aerial navigation. Of these, despite Mr. Maxim's brilliant work, we still know next to nothing; and, until we do, it appears to be rash and foolish in the extreme to employ motors which necessitate the bodily presence of the operator upon the experimental machines.

Daily Journals and Electrical Matters.

THE Birmingham *Daily Gazette*, which had the honour of discovering Mr. Thomas Budworth Sharp and his method of turning down electric lights, "has seen fit" to criticise, after a fashion, the criticisms of the electrical press concerning Mr. Sharp's arrangement. Our daily contemporary marvels at the density of electrical editors in failing to appreciate the importance of the invention. The objections urged by electrical editors were apparently quite wrong, for the Birmingham paper says "it scarcely requires any one with a deep acquaintance of electric lighting to discover that the arguments used are weak and easily answered." Indeed, so weak and easily answered are they that the Midland paper does not trouble to reply to them. We regret that we should have merited the castigation from our hardware contemporary, but we are buoyed up by the feeling that there are fellow sufferers. At the same time we would like to ask what earthly difference exists between Mr. Sharp's night-light arrangement of two lamps, and the combination lamp we described in our issue of June 1st, page 640. In principle the two plans are identical; only, in the lamp to which we refer, the two filaments are in the same bulb, a better and less costly arrangement than that of Mr. Sharp, although Messrs. Burbey, Williamson & Joseph illustrated their method also by means of separate lamps. Moreover, if Mr. Sharp does not attach any importance to the revolving disc make and break, we can assure our contemporary that there is nothing left for him to claim, for the switching of lamps into different combinations is quite old and known to all electric light engineers, but to them, as to ourselves, the econony of the arrangement is not obvious. The idea of using 1½ ampères to make three lamp filaments merely glow, savours rather of extravagance, when ·6 of an ampère will keep a single filament at a luminosity of 16 C.P. Suppose Mr. Sharp runs his night light at ·2 ampères for, say, eight hours per night, he consumes about 160 watt hours costing, say, at 7d. per unit, a trifle over a penny. The *Electrician*, therefore, is quite justified in doubting the economy of this bedroom adjunct, and suggesting the use of night lights at 5d. per dozen, costing less than one halfpenny per night. But beyond all this, the whole system of using incandescent lamps is entirely opposed to the plan proposed by Mr. Sharp, for the old days of placing lamps in series to suit machines which are now obsolete have happily gone, never to return. It is due to our contemporary to say that it is absolutely unbiassed in this matter, for it remarks:—"We hold no brief for Mr. Sharp, and the article we published merely set forth our own views on the matter."

An Electrical Method for Chemical Research.

AN elegant electrical method for the determination of "transition points" has recently been worked out by E. Cohen, thus affording another instance of the invaluable services which electricity can render to the sister science, chemistry. It appears that if a voltaic element be formed by the immersion of similar electrodes in saturated solutions of the two forms of a substance capable of undergoing a transition change, then at temperatures above or below that of the transition, the electric current will flow in opposite directions, becoming *nil* at the transition temperature itself. This experimental fact is the principle upon which the method of determination is based. Such an element as we have described is placed in a thermostat, and the current measured at various temperatures, the null point being carefully observed. Full details of the method, and of the mode of preparing the element and the electrodes, are given in the *Zeitschrift für Physikalische Chemie*, Vol. xiv., pp. 53—92. Although it affords advantages which are incomparable, especially as regards accuracy and speed, it is obvious that the method is only applicable to conductors, whilst for some of them the preparation of the electrodes would be a matter of considerable difficulty.

THE ELECTROLYTIC PRODUCTION OF CHLORINE AND SODA.

By EMILE ANDREOLI.

I would certainly hesitate, I would hardly dare to discuss, dispute or contradict, the intelligence news of the *Times* on political matters; but when it gives to the public the *primeur* of a discovery or of a new process, I am bolder and braver, and without apologising in any way, I contend that the technical papers ought to be the first to investigate and appreciate the new wonder, and to see it at work. It is almost a breach of etiquette for them to trespass on the ground of the technical press, and to give the assistance and the prestige of an advertisement in a largely circulated paper to a thing which has not obtained the sanction of competent men, and which, perhaps, is worthless or, at all events, is not worth the popularity which the daily press confers among the general public.

It is usual for people who write or deliver lectures on the production of chlorine and caustic soda by electrolysis to predict that the Leblanc and Solvay processes are doomed, and that a new system has been found which will revolutionise the alkali industry, and supersede everything which has been done up to the present. There was an article on the Castner process, "The Electrolytic Production of Chlorine and Caustic Soda," in the issue of the *Times* of the 20th ult., the author of which did not fail to make what irreverent French students call a *laius* on the subject; *i.e.*, a discursive exordium, and it is just to say that the opening sentences of the article were cleverly prepared, and possessed every requirement to favourably impress the reader. Unfortunately there is a little too much enthusiasm in the description of this new electrolytic apparatus, which is so superior, so efficient, so cheap, and so perfect, that all the others are nothing in comparison to it.

There are three methods for producing chlorine and caustic soda by electrolysis.

1. The decomposition of chloride solution, with electrodes not absorbing the products of electrolysis.
2. The mercurial process in which mercury is used as a cathode to form a sodium amalgam.
3. The dry process or electrolysis of fused chloride of sodium or potassium.

The Castner process belongs to the second category of electrolytic decomposition, and my remarks on the most prominent passages of the article of the *Times* will be the following:—

"This process *differs radically* from any of the numerous processes that have been attempted to be put in operation for the electrolytic production of soda." There is no radical difference in this apparatus, which is constructed like those which were and are still used in the electrolysis of fused salts.

"Its essential feature is the employment of a *moving body of mercury*, which completely separates the products of the electrolysis, and by its movement takes the place of a diaphragm, the amalgam formed by the electric action being decomposed electrically as rapidly as it is so formed."

Nearly all the electro-chemists who, before Mr. Castner, have used mercury in the decomposition of chloride of sodium into chlorine and caustic soda, have employed a moving body of mercury. The only difference is that in the Castner process the tanks are continuously tilted or rocked, so as to give to the contained mercury a flowing motion from side to side. "The process is, of course, *continuous*, and it has demonstrated, among other results, that the electrical efficiency is as much as *88·90 per cent.*; that no *hypochlorites* are produced, their production being a defect in other kindred processes; that the *solution forming and carrying the electrolyte* is in continuous use; that the *electromotive force required for each cell* is low, due to the non-accumulation of sodium in the mercury, and particularly to the fact that the electrodes are brought almost into contact."

A non-continuous process would be worthless. Mr. Castner is not the only one who has no trace of hypochlorite in his solution; we know of other processes in which the electrodes are brought almost into contact, and in which the electric efficiency *is more* than *88·90* per cent., and the E.M.F. low. I do not find anything remarkable in the Castner process and its E.M.F. being low, I am surprised not to find stated how many volts are required. But since writing this short criticism, I have found in the *Engineering and Mining Journal* of New York (September 22nd, 1894), a long illustrated article by Mr. H. Y. Castner himself, in which he says that "the electromotive force required for each cell is 4 volts for a current of 550 ampères, and that the electrical efficiency is from 88 to 90 per cent. "The process, adds the *Times*, has now been in regular operation at Oldbury for over *six weeks*, and it has been found that each cell, which is 6 feet long, 3 feet wide, and 6 inches deep, decomposes 56½ lbs. of salt daily, producing 38½ lbs. of caustic and 34½ lbs. of chlorine in 24 hours, for an expenditure of *3½ I.H.P.* The caustic solutions produced contain 20 per cent. of caustic soda, and yield by direct evaporation a solid caustic of 99½ per cent. purity, while the chlorine gas is of 95 to 97 per cent. purity, the balance being hydrogen."

There is nothing particularly surprising in this.

I do not underrate the Castner process, which may be good, extremely good, but which in no way does more than what a good process, based on the employment of mercury, must do.

But I point out the excess of enthusiasm which is shown by the writer of the *Times* (very likely Mr. Castner himself), and at the same time how little he was justified in singing the praises of this process, which, according to him, will supersede the Leblanc and Solvay processes.

The day, perhaps, is not far off when the electrolytic process will compete with the chemical manufacturers as much, or more, than electric lighting does with gas. But I doubt that the Castner process itself will not be superseded long before that day. What strikes me in the very long and complicated description made in 1892, by Mr. Castner, of his process, is the following sentence:—

"In the place of carbon anodes, any other suitable material, capable of resisting the action of chlorine, may be substituted, and the same principle may be applied to the electrolysis of fused salts using a *molten metal, such as lead, tin, or the like*, or an alloy of various metals in place of mercury."

This production of a sodium alloy indicated by Mr. Castner in 1892, and which had already been demonstrated in America in 1889, is just the basis of the process patented by Mr. Vautin for producing chlorine and caustic soda, and which, of course, like all other dry processes, gives still better results than those which the *Times* admires. The sole question is to know how the electrolysis of fused salt will behave on a commercial scale, and Mr. Castner is not very sweet about it, although he electrolyses fused caustic soda, since in the *Engineering and Mining Journal* he says that owing to the *low efficiency*, the *high electrical resistance*, and large *wear and tear of apparatus*, it presents so many difficulties as to *render any success in that direction almost impossible*.

NOTES ON THE STEAM TURBINE.

By KENELM EDGCUMBE.

(*Continued from page* 373.)

Unless an engine works continuously at full load, or nearly so, its consumption of steam per B.H.P. hour is greatly increased. This is largely to be attributed to the effect of mechanical friction at light loads. Suppose we have an engine of 115 I.H.P. and 100 B.H.P. at full load, its efficiency will be $\frac{\text{B.H.P.}}{\text{I.H.P.}} = 87$ per cent. Now since the speed must be constant, we shall probably fall into no great error by assuming the friction the same for all loads, namely, in this case 15 H.P. This assumption will give at three-quarters load I.H.P. 90, and B.H.P. 75, $\therefore \eta = 83$ per cent., at half load $\eta = 77$ per cent., and at quarter load $\eta = 62$ per cent. When it is remembered that in most electric light stations the engine load factor will probably on the average not exceed two-thirds, the great importance of a high light load efficiency will be at once apparent. Now, in the matter of friction, it will be readily admitted that a simple wheel, rotating between well lubricated bearings must, even at a

very high speed, run with considerably less friction than an engine with piston valves, &c., even though running at a very much lower speed. Here probably lies the chief cause of the remarkable light load efficiency of the steam turbine.

There is, however, another great source of inefficiency which has to be guarded against, namely, back pressure. Now, the work done by the steam depends on the mean pressure (P_m) exerted throughout the stock, whereas the external work performed depends on the effective pressure (P_e). Now, since the pressure of the atmosphere is 14·7 lbs. per square inch, $P_e = P_m - 15$ (at the very least). It will be readily seen that what at full load and high pressure may be but a small loss, becomes at light loads, where the pressures must be correspondingly reduced, a very serious one. Take for example an engine with a mean pressure of 75 lbs. (abs.) :

Load.	P_e.	Back pressure.	P_m.	$P_e : P_m = \eta$.
Full	60	15 lbs.	75	80 per cent.
¾	45	15 „	60	75 „
½	30	15 „	45	67 „
¼	15	15 „	30	50 „

It thus becomes essential to reduce as much as possible this back pressure of the atmosphere, for, apart from the direct loss of power, the range of temperature ($T - t$) in a non-condensing engine is considerably smaller, for in this case t cannot be reduced below 212 degrees. Condensation, of course, adds somewhat to the plant used, as well as increasing the frictional losses, since a pump is required to remove the condensing water, and any air which may have entered with it. Also, indirectly, a saving may be effected by the use of the non-condensed steam for heating purposes, as well as to raise the feed water to a higher temperature.

From the formula, W, α, P, L, A, N (where W = work performed, P = effective pressure, L = length of stroke, and A = area of piston) it is evident that the output may be varied according to the required load in several ways. Firstly, by varying N—this would be a most effective method, as reducing friction and back pressure losses in proportion to the load ; it is, however, out of the question in the case of electric light engines, as involving a corresponding fluctuation of the volts. An equally good method would, for the same reasons, be to vary the length of stroke, L, this is however, from practical considerations impossible. The more usual plan is to vary the mean pressure (P_m), and with it P_e, in one of two ways, either by reducing the initial pressure (P) by throttling, or, secondly, by varying the ratio of expansion (r). The formula usually given to represent the mean pressure is :—

$$P_m = P\left(\frac{1 + \text{hyp. log } r}{r}\right)$$

Both the last methods are open to the objection that they increase the influence of friction and back pressure at light loads. Of the two, however, the latter is much to be preferred, as avoiding all throttling and its attendant evils. Lastly, the area (A) of the piston may be varied. In the ordinary cylinder engine this is hardly possible. Dr. de Laval has, however, as will be seen later, introduced this method with great success into his steam turbine.

We now come to what has always been urged as the great objection to the adoption of the steam turbine, namely, its necessarily high speed of rotation. The chief reason for this speed is the high velocity acquired by steam issuing from a jet. We referred above to the plan of increasing the number of stages in which expansion is completed, as a means of reducing the steam velocity, and, therefore, the revolutions. This method, of course, adds somewhat to the internal resistance to the flow of steam as well as increasing the size of the motor. The whole question of speed seems, however, to have been somewhat exaggerated. Obviously, the only question is whether a turbine and direct coupled dynamo can run at the required speed without excessive heating or wear, and it has been shown that they can, and that, moreover, owing to the small number of bearing surfaces required, the consumption of oil is actually smaller than in the case of the cylinder engine. In the latter it must be remembered that the whole mass of piston, valves, &c., has to be stopped and again set in motion, twice during every revolution, from which considerable hammering, &c., must result. With the turbine it is a very different matter, however, where not only is the speed of every part constant throughout, but in which there are no rubbing surfaces whatever.

The advantages attending the use of high speeds in dynamo design, both as regards reduction of size and weight as well as increase of efficiency, are well known. The following example will serve to illustrate this point : suppose we have a series wound dynamo giving V volts, and A ampères, at, say, 1,000 revolutions, and having an internal resistance, R_i. If, now, the N conductors on the armature be coupled up in two parallels, so as to reduce N by one-half, the armature resistance will have only a quarter of its former value. The same may be done with the field coils. Now, by doubling the ampères, the field will be the same as before, and by increasing the speed to, say, 4,000, the volts will be doubled, and hence the output ($W_e = V \times A$) four times as great as before. Meanwhile, the internal resistance has a fourth of its original value, and therefore the $C^2 R$ losses, or internal watts (W_i), are as before. Assuming the former efficiency to have been 90 per cent., we have

$$\frac{W_e}{W_i + W_e} = \frac{90}{100}, \text{ and hence for } W_i = 1, W_e = 9;$$

but W_e now $= 9 \times 4 = 36$, and $\therefore \eta = \frac{36}{1 + 36} = 97{\cdot}3$

per cent. Hence, while the output is equal to that of a machine of, say, three times the weight, the electrical efficiency has been raised from 90 per cent. to 97 per cent., with an increase of speed, such as to render it possible to couple the dynamo direct to the turbine. The question of speed thus becomes merely one of maintenance, and this time alone can decide.

Much has of late been heard of the non-polar (or less correctly the unipolar) dynamo, and various methods have been proposed for increasing its necessarily low voltage, such as running several armatures in series, &c. The simplest way of arriving at the same result is clearly to increase the speed, and to this end it has been proposed to couple the armature direct to a steam turbine. Prof. Forbes has described a dynamo on the non-polar principle, having an armature 6 inches by 9 inches in length, which, at 2,000 revolutions per minute, gave some 5,000 ampères at 2 volts. The inventor further claims that with an armature measuring 4 feet by 4 feet, a voltage of 60 would be obtained at 1,000 revolutions, and that the ampères might reach 320,000. Though such a current is obviously out of the question, yet by increasing the speed to, say, 4,000, a considerable reduction in size and weight could probably be effected. Should it ever be thought desirable to introduce this type of generator, the turbine will probably be found a suitable motor for the purpose ; but with the present high dynamo efficiency such a change seems hardly needed, unless possibly, in some electro-chemical industries where low voltages only are required.

We will now briefly consider the chief points of a few steam turbines in actual use and compare their economy in working. They have, however, most of them, been so frequently described and illustrated, that a very brief outline will here suffice.

Probably the simplest turbine in point of construction is that devised by Dr. Gustaf de Laval, of Stockholm. This motor has several points of interest. In the first place, the entire expansion, of from 120 lbs. (abs.) to 1·3 lbs., is performed in one stage. The steam is directed against the curved blades by eight conical nozzles, of the form shown in fig. 2. In these latter, expansion is carried to such an extent that the pressure of the steam is reduced almost to that of the exhaust. This results in a considerable amount of superheating, which prevents condensation, thus reducing, to a great extent, the internal resistance to the flow of steam. Beyond this, however, it is difficult to see how it conduces to the economical working of the motor. In this connection an experiment of Mr. Morton's* on a jet of somewhat similar form may be noticed. The tube in question, tapered from $\frac{3}{16}$ths inch to $\frac{5}{8}$ths inch in diameter, and on steam being

* Paper by Mr. Alex. Morton "On Rotary and Reaction Steam Engines," December 19th, 1893, before Institute of Engineers and Shipbuilders of Scotland.

admitted a partial vacuum was registered by gauges placed at points along the walls of the tube. With a curved jet it was found that a pressure was exerted on the concave, and a partial vacuum along the convex side. Practically the same results were obtained with the tubes surrounded by steam jackets. It thus appears that steam under these circumstances behaves much as water would, and it is for this reason claimed that the energy of steam should, as employed in the De Laval turbine, be more efficiently converted into mechanical motion than in the ordinary engine. However that may be, it is impossible to avoid the fact that the source

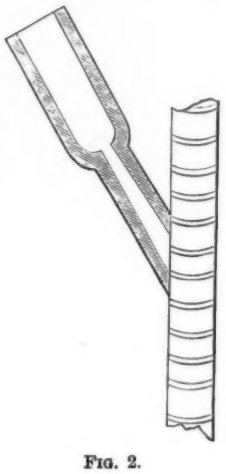


Fig. 2.

of power depends on the fall of temperature involved, no matter how the steam be employed. It would seem also that the expansion would be more usefully accomplished in two stages, which would have the further advantage of somewhat reducing the high speed which is at present unavoidable. This speed, which reaches, in fact, 30,000 revolutions per minute in the smaller sizes, is reduced to the ratio of 1 to 10, by a fine cut steel skew-wheel gear. Since the velocity of the driving pinion is so high, the power to be transmitted by it is correspondingly small, and hence the cogs can be greatly reduced in size, a fact which probably has much to do with the remarkably smooth running of the gearing.

(To be continued.)

STANDARD UNITS FOR ELECTRICAL MEASUREMENT.

(*Continued from page* 293.)

II.

We have now to mention what may be regarded as the true completion of the labours of the B.A. Standards Committee, by the taking over on the part of the State of the onus of providing units for electrical measurement. It will be remembered that in December, 1890, the Board of Trade appointed a committee to consider and report upon the action to be taken by the Board of Trade under the Weights and Measures Act, 1889, with a view to causing denominations of standards to be made and verified. Two members each were appointed on the committee respectively representing the Board of Trade, the Post Office, the Royal Society, the British Association, and the Institution of Electrical Engineers. This committee agreed to a report, and separated on June 30th, 1891. A little more than a month ago, August 23rd, 1894, Her Majesty in Council approved of an order by which the several denominations of standards set forth therein are legally established and legalised as "new denominations of standards for electrical measurement for use in trade." The ohm, ampère, and volt have now a legal significance, and the standards of the Board of Trade constitute the British concrete realisations of the international units of resistance current, and pressure.

On page 275 of our issue for August 31st, 1894, we gave the order in council in full, which was the instrument by which the units were established. It will be remembered by those who have studied the proceedings of the Board of Trade Committee that unanimity prevailed as to the advantage of immediately arranging the basis upon which standards for use in trade would rest. The Association of Municipal Corporations put the matter very clearly in a report which that body submitted to the Board of Trade Committee when asked to give evidence. They were of opinion that, assuming that the science of electricity had advanced so far that it was then possible to define the three units referred to in the letter from the Board of Trade, and to construct an instrument (or instruments) for the purpose of standard measurement, the time had arrived for the Board of Trade to take action thereon.

The committee did take action, and the units were duly discussed. As was to be expected, the toughest fight was over the alternating ampère, and it has since been the favourite *bon mot* of the then president of the Board of Trade, that although he was the responsible party in carrying out the resolutions of the committee, he was totally in the dark as to what the alternating ampère really was, and quite at a loss to give an explanation of the highly technical definition of its unit value. It was shown by evidence given before the committee that it was essential that supply meters measuring energy consumed by customers of electric lighting companies should be stamped under the Weights and Measures Act. There was no necessity to have other instruments stamped, except in so far as they may be the legal means of determining whether the testing clauses of provisional orders are complied with and whether the variations, for example, of pressure from the "declared standard value at distributing points" are, or are not, in excess of the amounts permitted by the regulations for safety and for supply made under such orders.

The latter points are of more importance to corporations who have appointed an electrical inspector upon their staff. The appointments under this head are gradually being made, and, to render the work of such officials of any value, they must be provided with units and with means of determining the values of pressure, current, resistance, and energy, in terms of standard unit values which have a legal as well as a scientific significance. As a matter of fact it is to be expected that everyone who uses voltmeters and ammeters and other instruments, will certainly have them verified and calibrated, or tested, if possible by the Board of Trade laboratory, and the officials of this department may expect to have an immense amount of work thrown upon their shoulders now that the resolutions have been adopted, and a formal declaration of their value issued. The end of the work of the committee was, however, to submit the resolutions to the Board and approve of them in the report. A sub-committee went to great pains in determining the best forms of instrument to be used for each measurement, and in arranging for the apparatus in which form the concrete values of the units would be realised.

The Electrical Standards Laboratory.

The electric lighting department of the Board of Trade was, from the first, associated with that exercising control over the railway system of this country, and the two departments, of which electric lighting was the most recent and undertaking the smaller amount of work, were for some years given joint accommodation. The offices of the latter were permitted to house the officials who gradually were appointed to supervise the works for which powers were granted by license and provisional order. When, however, the work of the Standards Committee began to bear fruit it became necessary to provide other buildings for offices, and the idea of establishing a laboratory, where comparisons of standards and investigations into the meter question could be conducted, led to the removal of the two departments to 8, Richmond Terrace, Whitehall, a large house that had been chiefly used for several years by Royal Commissions, where the offices have remained up to the present. The Labour Department of the Board of Trade took up the vacated offices in Parliament Street.

The premises allotted to the Board of Trade standardising laboratory consist of the basement of a large residential mansion opposite the Home Office. Besides the basement the area is given up to the purposes of the laboratory, and this has enabled provision to be made for motive power and for battery storage in special buildings, clear of the laboratory proper, and capable of being easily and efficiently ventilated. The rooms forming the laboratory are: the main laboratory, or standards room, where comparisons of current and pressure measurements are made; secondly, the motor generator room, where are situated the machines for alternating and continuous current supply and the electromotor for driving them. Next to this, and forming the third section, is the testing room for resistance measurements, which is provided with the set of carefully calibrated instruments for this purpose, and is now maintained at a constant temperature by means of a thermostat.

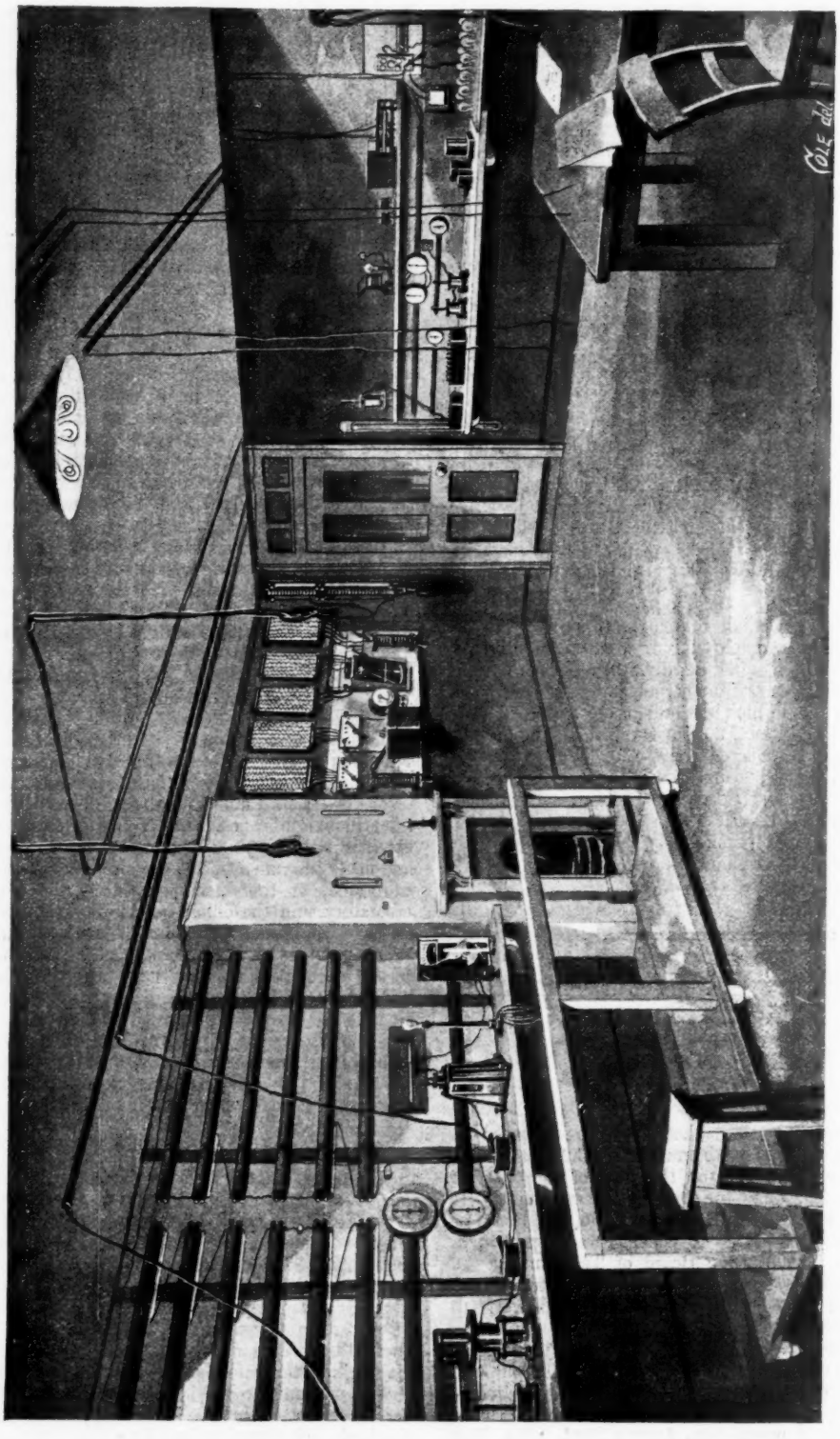


Fig. 1.—Standards Laboratory.

This arrangement is one of the things under consideration and trial, but will prove of no little importance considering the high accuracy to which measurements of resistance are pushed. At the other end of the suite of rooms the verification room is placed. Here the arrangements have been designed to facilitate the testing of commercial instruments

under conditions such as they will be subjected to in actual service. The height from floor to ceiling in the basement is only 8 feet, and now that the department has the means of going to work, a demand for greater facilities in the way of space could hardly be considered unreasonable. The last mentioned room, however, has only recently been added to the electrical laboratory, and this was done owing to the necessity for accommodation beyond that afforded by the instrument rooms then in use and which we have mentioned. So far as the room required for the instruments and apparatus capable of effecting electrical measurements between the prescribed limits of range and accuracy was concerned, the space was found sufficient, and where the premises were found to be rather smaller than was desirable, the available room was made sufficient.

The Standards Laboratory.

The laboratory is situated in the basement of the building mentioned, at the salient corner formed by the intersection of Richmond Terrace with Whitehall. The terrace runs at right angles to Whitehall, and the laboratory is therefore lighted by windows on two sides, looking out to the terrace and Whitehall respectively. The fixtures serving to support the instruments are simple, but excellently adapted to their purpose. A slate shelf, about 18 inches broad, resting upon corbels built into the walls, carries the ampère balances and other instruments of similar type. This shelf is placed about 30 inches above the floor, and extends along three sides of the room; the shelf runs underneath the windows of the two sides looking outwards, and also along that opposite to the terrace side. The entrance to the room is in the latter side, so that on entering one finds to the left and in front the apparatus for current and for pressures up to the limit of low pressure working. On the low pressure wall there is a second slightly narrower shelf, about 4 feet 6 inches above the floor.

At the high pressure corner on the right-hand side there is a platform enclosed by a rail, and carried on inverted oil insulators, with a view to minimise the danger of working with high pressure currents, and to reduce the liability to accidents when the pressure is run up toward the upper limit of range. As an additional safeguard, this platform is also furnished with an India-rubber mat, India-rubber gloves being used when switches or leads under pressure are being handled.

Fig. 1 gives one view of the standards room; this gives the appearance as seen looking towards the entrance door. On the left of the illustration the regulating switchboard for the machine room plant is shown, while on the right the set of instruments used for L.P. voltmeter tests is also indicated. To the left of the observer, when facing the fireplace, one notes the high pressure voltmeters and switches and the insulated platform. The general appearance of this portion of the laboratory is very well indicated. With the connection of instruments and apparatus we shall deal fully when considering the methods of testing and apparatus used for checking and calibrating work. Next in importance to the standards room is that in which commercial instruments are tested. Although this is at the other end of the suite of rooms, it will be best to say something about it before considering the sources of electrical energy peculiar to this establishment.

Verification Room.

About two years after the laboratory had been established in a small way, the increase in work attempted made it necessary to devote more room to the purpose. This was effected by alterations which practically doubled the available floor area, and the additional space was divided into a good dry store room with ample shelf accommodation, a small closet for chemicals fitted with a water supply and ventilators for getting rid of chemical fumes, and an apartment larger than the main laboratory. This last room has been fitted up, as shown in fig. 2, for commercial testing generally, and particularly for the work on meters, which has grown from small beginnings until it has become of considerable proportions, and is likely to increase rapidly in the future. The cables and instruments fitted here will provide for a range of measurement up to 130 volts and 200 ampères, alternating or direct. By the provisions of the Electric Lighting Acts, any electricity meter to have a legal value must be of a construction and pattern approved by the Board of Trade. This meant that each type of meter had to be subjected to long, varied, and searching tests by the officials, as such certification marked with Government approval all meters of that particular construction. The first of any type of meter has rarely been found to be satisfactory, and second, third and others have usually followed, so that the testing of meters carried out in the laboratory often seemed to be merely done for the purpose of guiding their makers in developing good points, and eliminating bad ones. The result, however, of all this work has been on the whole a great improvement in the accuracy of meters generally, and that is an influence due to the work of testing, which has not been brought to bear in vain, and which tends to nothing but good.

One evidence of the care which is expended in testing meters is afforded by the runs which are taken under reduced air pressure. Now, in this room, as it was taken over by the electrical department, was a large cooking range; but

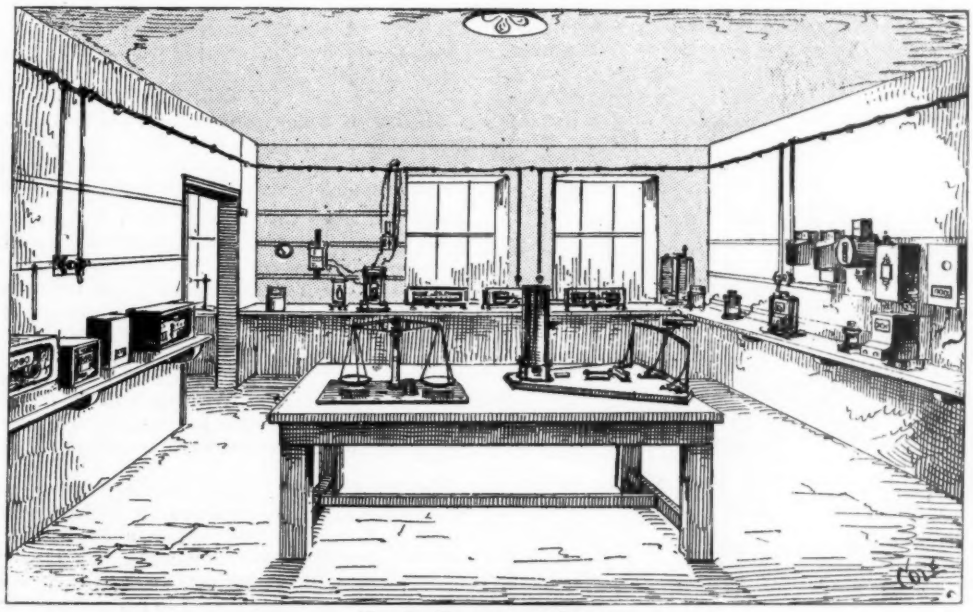


Fig. 2.—Verification Room.

this had to be removed, and in its place a gas heating arrangement, with large brick chamber, for testing the effect of temperatures upon instruments, was put in. It is hoped that it may be possible not only to arrange for heating but also for cooling this chamber, covering a range of from − 10° C. to + 80° C., and also to have the pressure capable of regulation between air at atmospheric pressure and something about 5 inches below this. The current leads round the room are very carefully disposed so as to obviate any interference with the meters and apparatus. Pressure leads are also provided with terminals at intervals, but the testing arrangements will be dealt with as a whole when speaking of the system which has been evolved after varied experience on the part of Major Cardew, the electrical adviser to the Board of Trade, and Mr. J. Rennie, the electrician. To these gentlemen the writer is deeply indebted for much information and for many interesting visits to the laboratory, where the time spent has been amongst the most enjoyable of his experiences. The unfailing courtesy with which he has been met, and the trouble taken to make clear the whole of the somewhat elaborate arrangements have laid the writer under an indebtedness for which he has to tender his best thanks to these gentlemen.

Engine and Battery Rooms and Cable Tank.

This is an erection about 27 feet long and 7 feet wide in the area, a passage about 3 feet wide being left along the front of the basement. The lean-to erection is of corrugated iron, and has a concrete floor about 24 inches deep, formed with foundation beds for the engine and two dynamos. Although the laboratory is provided with a supply of electrical energy from the mains of the London Electric Supply Corporation, the transformer house for this purpose being placed at the southern end of the area, close to, but not adjoining, the engine room, the requirements of accurate calibration work made it necessary for the main supply being taken from sources which are under the control of those engaged in the laboratory. This makes certain of obtaining current at any time, and without the risk of interference from outside causes, while it also permits of greater ease in regulation.

The head room available for the engine house is under 6 feet, as the building line has been kept below the level of the front area wall facing Whitehall. In the engine-room is placed the plant from which energy is obtained for testing purposes. This consists of a 4-H.P. gas engine of the Otto type, embodying all the recent improvements of Crossley's make, and arranged to drive one or other of two charging dynamos by belt drives of some length. The engine is fitted with tube igniter, and with a silencer on the exhaust pipe. The latter is a short cylinder, supported horizontally by four feet, and placed at the bottom of a brick-lined well 3 feet square, sunk 4 feet below ground. The chamber so formed is filled with a mixture of sand and gravel, and is closed gas tight by an iron plate. The pipe for conveying off the waste gases passes out at a point in the chamber, just beneath the iron cover, and discharges at a height of 30 feet above the street level. When the engine is running, the exhaust passes out of the pipe in a thin continuous stream.

(*To be continued.*)

CORRESPONDENCE.

The Action of Alternating Currents on Dielectrics.

When entering into the discussion of this subject, I had no intention of making more than a brief communication, as it is one to which I had not paid special attention for three or four years.

I am still away from my books, but in order to ascertain whether I was in accord with the latest experimental evidence, I called at the town library here (Wolverhampton) to consult the back files of your Journal, and those of your contemporaries. I find, however, that though your Journal and that of your chief contemporary are taken in, and notwithstanding that for several years there has been one factory employing 600 hands in electrical work here, and another nearly as large will soon be complete, yet the committee do not esteem their electrical journals worth binding.

Looking through the pages of Geipel and Kilgour's recent pocket-book, however, I have chanced across two determinations of sparking distance for alternating currents in air by Messrs. Siemens Bros. and Mr. Stuart Russell respectively, and a table giving De la Rue and Thomson's results for continuous currents. These results are given in three tables; but for the sake of comparison I have set them in juxtaposition. They give the sparking distance below parallel planes. It will be noted that Mr. Stuart Russell's results show a greater distance than Messrs. Siemens's, this being due to the fact that Mr. Russell has not given results for parallel planes, and I have therefore been obliged to take his nearest electrodes, viz, a sphere of 6 inches diameter and a cylinder of $\frac{3}{8}$ inch radius. The frequency of the alternating currents is 100 ~ per second.

The volts are:—Actual for continuous, and virtual or average for alternating.

Volts.	Sparking distance between planes—inches.		
	Continuous current.	Alternating current.	
		Siemens Brothers.	Stuart Russell.
2,000	·018	·026	·028
4,000	·039	·063	·060
6,000	·060	·100	·103
8,000	·085	·142	·153
10,000	·113	·189	·207

Making a slight allowance for the maximum being greater than that given by a sine curve, it will be noticed, that the results show that the sparking distance *in air* for alternating currents is, under the same circumstances, about $\sqrt{2}$ times that of continuous, or, say, nearly half as great again. The statement in your leader that the sparking distance in air for an alternating current was practically equal to that of a continuous current of the maximum pressure of the alternating, is therefore correct; in fact, this might fairly be inferred, after careful consideration, since if there is no adequate capacity in the circuit, the period of oscillation would be infinitely shorter than that of an ordinary alternating current, and therefore in the absence of a material which was liable to stress, or to a time effect, the full voltage of the current would be able to act at each alternation.

Having got so far, it next remains to ascertain whether their relative sparking distances are maintained in solid or liquid dielectrics; but on this, so far as I am aware, a good comparative series of tests is wanting. They would, however, be rather difficult to carry out, as the dielectric strength of the materials used for cables is so much greater than that of air. For instance, whereas the sparking distance for 10,000 volts alternating was found by Messrs. Siemens Brothers to be about $\frac{1}{8}$th of an inch in air, the average for rubber-covered cables was about $\frac{1}{225}$th of an inch, or $\frac{1}{8}$th of that of air. Again, Prof. Hughes's classic experiments showed some of the resinous oils to have a dielectric strength from 50 to 80 times that of air, which means that a film of $\frac{1}{250}$th of an inch thick would be capable of withstanding a pressure of 10,000 volts. As for mechanical reasons it is usually undesirable to employ insulation less than $\frac{1}{10}$th of an inch thick, while it often requires to be much thicker, the fact remains that in practice the dielectric strength of the materials in cables is, for ordinary pressures such as 2,000 volts, enormously in excess of the sparking distance. Thus the sparking distance for 2,000 volts alternating in air is about $\frac{1}{35}$th of an inch, consequently it is in rubber about $\frac{1}{1750}$th of an inch, or in good resinous oils about $\frac{1}{12500}$th of an inch.

As, however, you mentioned in your leading article, and as I pointed out in 1887, the sparking distance across an exposed surface of a dielectric may be three times this distance, and it is across such surfaces, the insulating qualities of which have been deteriorated by electrolytic or atmospheric influences, that breakdowns take place. Whether, however, there is a greater tendency for such action to take place with alternating than with continuous currents appears, as I stated last week, to be a moot point, and I am still inclined to think with Prof. Silvanus Thompson, that taking this point and

the soaking in effect into consideration, the balance in favour of the alternating current would be redressed, as at any rate the difference may, for practical purposes, be considered negligible. In this I am confirmed by Messrs. Callender's superintendent, Mr. W. Burton, of whom I have inquired whether, in their extensive experience, they have been able to observe anything which would lead them to suppose that alternating currents were more deleterious in their action on cables than continuous. He informs me that so far he is unaware of any difference.

This is all that need be contended for, and I think that the information which is collected above, together with the results of the practice of the last six or seven years, have made it abundantly clear that, so far as their transmission by cables goes, there is no commercial reason for considering alternating currents inferior to continuous, and that to found an argument on the advantages of continuous currents on this basis at the present day is quite fallacious.

G. L. Addenbrooke.

The Magnetic Properties of Asbestos.

It does not seem to be generally known that the asbestos of commerce possesses very marked magnetic properties.

In some recent experiments Mr. J. C. M. Stanton and myself found that, employing a very strong electro-magnet, a piece of ordinary white asbestos mill-board about $4 \times 3 \times \frac{1}{16}$ inches in size, and weighing $\frac{1}{2}$ ounce, was easily lifted through a vertical distance of $1\frac{1}{2}$ inch, and when in contact with the magnet pole the asbestos board would support 4 ounces in addition to its own weight.

Lumps of hard asbestos, such as are used in gas fires, as also pieces of soft asbestos cotton packing, were also strongly attracted, and when some of the latter was placed on the magnet pole and the current turned on and off, the individual fibres could be seen in movement.

Further, it is quite easy to permanently magnetise a piece of asbestos mill-board, when it will behave exactly as a magnet both in attracting and repelling a compass needle.

The principal constituents of asbestos are stated to be magnesia, silica, and alumina, with some oxide of iron. No doubt it is to the presence of the last-named substance that the magnetic qualities are due. White asbestos is, however, understood to contain but small traces of iron, much less than the coloured varieties—and consequently the degree to which it is magnetic seems surprising. In any case it may be well to warn experimentalists that asbestos is not a suitable substance to employ in connection with delicate instruments where any unsuspected permanent magnetism might be productive of serious error.

A. A. C. Swinton.

The Velvo Carbon Battery.

In answer to notes in your last week's issue:—

Prof. Jamieson has not yet been able to test one of the larger launch cells owing to vacation.

He will be completing his tests for the final report shortly, doubtless being very carefully made with standard instruments they are more reliable than my own rough tests in the boat, and will probably prove to be more in our favour, judging by his report on the smaller launch cell, some extracts from which you have printed, as in the case of these tests working conditions were necessarily departed from in leaving the cell charged all night (with local action waste going on), owing to the shortness of the laboratory working day.

Costly independent tests of my modified Walker cell against the unmodified forms either of that or of the Smee type, may be necessary when it has been shown that it is possible to keep in practical use a large battery of either model—not before. Users of these cells for the comparatively small currents required in electro-plating, &c., must, I believe, have experienced the same difficulties which troubled me.

I should be glad to know what combination will in a two-fluid cell give a terminal P.D. of 1·8 volts, and the current density per square inch zinc area at which this terminal P.D. is obtainable. I cannot get a constant terminal P.D. of more than 1·1 to 1·3 volts from a double fluid nitrate or chromic cell. I have obtained 1·5 volts from the Grove cell, but, unfortunately, that type is quite out of the running.

I find that *re* the "company syndicate" you are right—they are now selling a chromic salt in place of their old secret (?) fuming depolariser.

The agent's (and a presumably "fair") price for the best commercial zinc obtainable is now 21s. per cwt—this is not 5d. per lb. This latter price was quoted by me as the price for sets of launch zincs cut to size, amalgamated, packed and delivered.

Comparing our records of the quantity of zinc and mercury we have used, I find that one half-pennyworth of the latter metal is sufficient for the amalgamation (immersion and draining) of each pound of 16 zinc gauge zinc.

I do not see that you could possibly state a percentage of efficiency *for zinc consumption* in a battery in any other than ampère hours. There is no theoretical limit to the E.M.F. and consequent watts obtainable, but there is a limiting ampère-hour figure, towards which we strive to attain.

The measure of efficiency *for a battery* I take it should be expressed in terms of *all* the materials used; then if one is spending a pound of chromic salt to save a pound or less of zinc, the fact becomes at once apparent, and the inadvisability of doing so on grounds of economy and convenience manifest.

H. T. Barnett.

October 1st, 1894.

"Mechanical Draught."

The writer of these articles has raised a question which is well worthy of discussion; but he does not seem quite clear on the question of regulation of speed of fan, and I rather gather that he is not quite clear in his own mind upon the point. He says: "There must be no running of a fan at full speed with shut down dampers;" but then how is that possible when, as he says, "but the speed of the fan must be regulated to the demand for steam, and this is most easy to effect, the variation in the steam pressure controlling and varying the fan speed." This may be said to be true, and yet not true.

If you fire hard and increase the pressure, the fan will go faster and give more draught; but as the power required varies as the cube of the volume required, it will not answer to depend on the steam pressure alone. Again, suppose at a certain hour you damp down two out of six boilers, and require the same pressure in the remaining four, what would happen? the fan would run away until the work it was doing on the four found its level, by putting a greater vacuum upon those still working.

The proper solution of the question will be found in ascertaining the speed of engine and fan most suitable to an efficient draught on all the boilers. Then when you put two dampers down, a governor would maintain the speed, whilst doing less work. You must maintain the same vacuum upon the boilers still working, and this necessitates the same speed. I have not time to refer to the general question this week of mechanical *v.* heated column draught, which, in dealing with large volumes for mines, has for many years had my attention; but the question of black smoke seems to be the greatest difficulty.

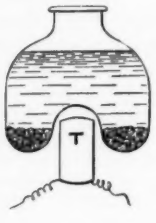
A. W. Steavenson.

ELECTRIC HEATING.

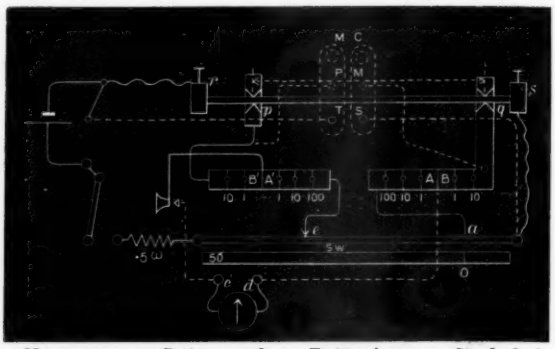
Until quite recently it has been assumed by electrica engineers generally that the cost of heating by electricity puts this method beyond commercial practicability; we are now witnessing, however, a complete change of attitude. It is true that at present electrical energy is usually more expensive than thermal energy derived directly from combustion. But in transferring the energy to the body whose temperature is to be raised, the advantage lies with electricity, for the losses of heat by conduction, convection, and radiation are very much smaller. The question therefore takes the form: Which in the end is more economical, the electrical energy, which is usually dear but convenient and adaptable, or thermal energy, which, though cheap, is very wasteful in its application? Some data are already available which bear upon this question and answer it in favour of

electricity, but more are wanting and we commend this as an interesting subject of research to those electricians who are desirous of bringing electric heating to the front.

One of the most recent attempts to provide an economical system of electrical heating is described in the *Zeitschrift für Elektrotech. u. Elektrochem.* It involves the use of induced currents. In its essential features, the apparatus by which the heating is effected is as follows:—A vessel of suitable heat-resisting and, preferably, non-conducting material is constructed with a deep indentation in the bottom (*vide* accompanying fig.). Into this indentation or hollow is



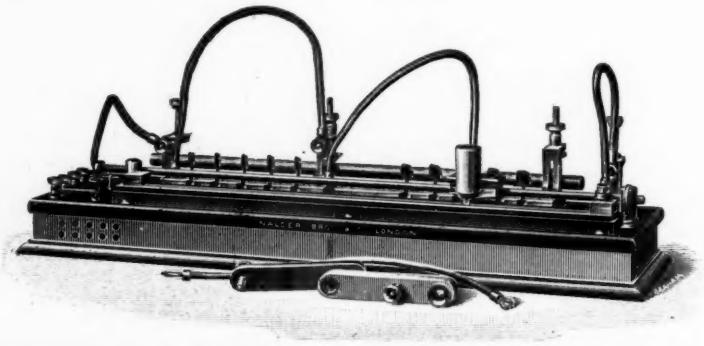
inserted the single primary coil of a coreless transformer, T. Within the vessel is a ring of lead, or, as shown in the fig., of carbon fragments, which becomes heated by the induced currents flowing in them when a suitable current is passed through the primary coil. If the vessel be made of metal, it will itself act as a secondary conductor, and no additional ring of lead or carbon will be needed. The apparatus is claimed to be very efficient.



M C, Mercury cups; P M, Part measured; T S, Test specimen; S W, Standard wire.

3 or 4 ampères when using one secondary cell which passes through the platinoid wire, and through flexible connections and clamps (r and s) to the test specimen. Two of the ratio arms are connected to the knife edged clamps (p and q), the other two being joined to the fixed (a) and sliding (e) terminals of the standard wire. The galvanometer terminals (c and d) are connected to the junctions of the ratio coils.

When using the apparatus for testing resistance coils, the bars carrying the mercury cups are screwed on the base, and are then in the battery circuit. Each bar carries a terminal from which flexible connections are made to the ratio coils. The connections for this arrangement are shown by dotted lines.



NEW FORM OF THOMSON BRIDGE.

The accompanying illustration shows a new form of Thomson bridge, designed and constructed by Messrs. Nalder Bros. and Company, both for the purpose of testing very low resistance coils, and of taking conductivity tests of bars. It is arranged with the object of securing the most portable and compact form combined with great accuracy. The whole apparatus is on a single ebonite bed 2 feet 6 inches by 7 inches, thus attaining the shortest possible connections throughout.

The standard resistance consists of a platinoid wire of 50 cms. working length, having a total resistance of about ·013 ohm. The contacts on to this wire are made by a single sliding contact, and a fixed contact near one end, the zero of the scale being determined with respect to the fixed contact. The resistance to be tested if of bar form, is fixed in two clamps with knife-edged jaws adjustable to any size of bar up to 1 inch diameter, one of which clamps is movable, to suit the length of the bar. In this case only three flexible connections are used, two of which, being in the battery circuit, do not introduce any error due to their resistance. If the test resistance is of the form of a coil, two large copper bars bearing mercury cups are used, in which case, also, only three connectors are used. In all cases the length of these connectors is very short, and this, combined with their small number, allows the ratio coils to be of fairly small resistance, which increases the sensitiveness of the arrangement by the aid of a low resistance galvanometer.

The diagram shows the arrangement of the instrument when used for testing bars. The battery circuit is completed through a switch and resistance to reduce the current to

The principal points in the construction of the apparatus are the use of a single sliding contact, and the shortness and fewness of the outside connections.

NOTES.

Fire.—A fire, caused by the over-heating of an electric light wire, broke out on Saturday morning in a large sugar works at St. Ouen. The fire originated in a building separated from the central block and used exclusively for crushing the cubes. The flames, communicated to the woodwork by the wires, were fanned by the draught up the elevator shaft and soon obtained a firm hold. The fire was got under after five hours' work. The damage is estimated at more than a million francs, and 250 employés are thrown out of work.

St. Thomas Charterhouse Schools. — A Saddlers' Scholarship has just been awarded to Herbert Rainbow, and a free studentship to the Finsbury Technical College to Alfred Bossom. Thus for nine years pupils of the above school have carried off these valuable prizes. Eight pupils have just passed the matriculation test of the City and Guilds of London Institute, and, so far, no pupil has failed to pass the entrance examinations of the Finsbury Technical Institute. The Clothworkers' Technical Scholarship, of the value of £250, was recently gained by Ernest Cook. The school has always secured this exhibition. At the late science examinations, 44 first class and 53 second class certificates were obtained.

The Gigantic Wheel at Earl's Court.—It will be remembered that the gigantic wheel was intended at the time of its commencement as an additional attraction in connection with the recent Earl's Court Exhibition, but as it was found impossible to complete the wheel in time, the exhibition doors were closed a few weeks earlier than was originally arranged, and is usual. A few particulars regarding the structure may not be uninteresting. The wheel is 300 feet in diameter. The horizontal axle, which is now in position, weighs 53 tons. There will be 40 carriages suspended from the wheel, each having a carrying capacity of 40 passengers. Up to the present, however, only one of these carriages has been delivered; two 50-H.P. Robey steam engines will rotate the wheel. Each of the carriages will be lighted by electricity, and there will be a double line of electric lamps all round the rim of the wheel. A separate engine is provided for driving the dynamos. Messrs. Statter are responsible for the electrical part of the work.

Technical Education.—Intending students should have no difficulty this winter in choosing classes in electrical engineering and allied subjects, unless it is because there is so great a number of them. We have already referred to the Finsbury Technical College, Telegraphists' School of Science, the Charterhouse Schools, and the People's Palace announcements, and have now before us particulars of two more sets of classes. At the City and Guilds Technical College, special courses of evening instruction have been arranged for apprentices and other persons engaged in electric lighting, telegraphy, telephony, electro-plating, and other branches of electrical engineering; also a special course of four lectures on "Central Stations for Electric Lighting," which commenced last night. At the Polytechnic (Y.M.C.A.), Regent Street, W., special courses of instruction in electrical engineering and experimental physics have been arranged, under the direction of Mr. W. Hibbert, F.I.C., A.I.E.E., assisted by Messrs. Thorrowgood, Field, and Cripps. Electric lighting and distribution of power, electric bells, and electro-metallurgy, are among the subjects. The course commenced on Monday last.

The prospectus of the day classes to be held at the Owens College, Manchester, during the present session, and the annual statement showing the results of the past year's work, are also before us.

The Institution of Civil Engineers.—The Council of the Institution of Civil Engineers invites original communications on the subjects included in the following list, as well as on any other questions of professional interest. This list is to be taken merely as suggestive, and not in any sense as exhaustive. For approved papers the council has the power to award premiums, arising out of special funds bequeathed for the purpose:—"The Production and Use of Superheated Steam," "The different Methods of Governing Steam Engines, so as to give Uniform Speed with greatly varying Loads," "The Arrangements of Boilers and Engines best adapted for Electric Light Stations under different conditions," "The relative merits of the several Cycles in Gas Engines," "The Purification of Sewage by Filtration, Precipitation, Electrolysis and otherwise," "The Means and Appliances, other than sewers, for dealing with the Refuse of Towns," "The Theory and Practical Working of Single and Multiphase Alternate Current Motors, illustrated by examples of existing installations," "Alternate *v.* Continuous Electric Currents for (*a*) Electric Lighting, and (*b*) Transmission of Power," "The Forms of Electrical Conductors for Lighting, stationary power, heating and tractive purposes," "The Utilisation of Electric Lighting Plant during hours of small demand," "Electric Lighting and Haulage Plant in Mines and Collieries," "The Application of Water Power, and its transmission to a distance by electricity," "Electrical Motors for (*a*) Inland Navigation, and (*b*) Ocean Vessels," "The Use of Electrical Motors for driving machine tools in engineering workshops," "The Electrolytic Deposition of Copper."

The roll of this Institution, corrected to September 6th, 1894, shows that there were then on the books 19 honorary members, 1,837 members, 3,597 associate members, and 358 associates—together 5,811. There is also a class of students attached to the Institution, but not forming part of the corporation, which now numbers 782.

The Recent Fatal Accident at Leicester.—The inquest on the body of Hugh Smith, the youth who recently met his death at the Midland Railway station, at Leicester, was continued on Tuesday, Mr. W. E. Langdon being among those giving evidence. The cause of death was stated to be hemorrhage, due to the fracture of the skull, through the youth being caught in the gearing of the machine. The coroner considered that the evidence contained nothing to show that electricity was the cause of the accident. A verdict of accidental death was returned.

New Journal.—*L'Energie Electrique* is the title of a new journal being published in Paris. The editor announces in the first number, October 1st, his intention to publish articles on all matters connected with the electrical industry, at the same time pledging himself to the exclusion, as far as possible, of technical language. The notes give a good deal of information regarding electric lighting in the French provinces. The journal, as a whole, is devoted more to the commercial than to the scientific side of electricity.

English Cables and the Madagascar Question.—Now that the mission to Madagascar is being so much talked about, and the probability of a military expedition discussed, attention is once more drawn in the French press to the fact that all the confidential communications which M. le Myre de Vilers will have to make to his Government will have to pass over an English cable, and stress is laid on the great harm this may cause to France. The matter, says a Dalziel telegram, is even considered so important that an agitation is being got up with a view to inducing the Government to organise independent cables all over the world, and to see if one of the great French telegraphic companies cannot be induced to lay one immediately for use during the approaching military operations.

Obituary.—We regret to chronicle the death, on September 30th, of Mr. W. Topley, of H.M. Geological Survey. Mr. Topley was, perhaps, best known as the authority on the Geology of the Weald. This he had thoroughly mastered, and he was a most safe guide in all matters relating to the district, not but what he was also a sound general geologist. They who had the privilege of knowing Mr. Topley, even slightly, have heard of his death at the early age of 53 with sincere regret. His knowledge was always at the command of practical men, and his advice was given in a manner that made one feel that to follow it would lead to success so far as human judgment can lead one, and success followed in the majority of instances where Topley led. He was indeed one of the few of our present-day geologists who did not clothe his advice in a plethora of subjunctives.

Fatal Accident at the Bankside Station.—The following facts regarding the Bankside accident have been furnished by the City of London Electric Lighting Company, Limited:—Last Sunday afternoon two *employés* of the Brush Company were repairing one of the switch pillars, which stand about 20 feet apart, along the switch gallery of the station at Bankside. One of the men—a fitter—was at work behind the pillar, about 5 feet from the gallery floor, having used a ladder for getting up. His labourer, a man named Hearne, took the ladder away unnoticed, placed it against an adjacent pillar which was "alive" at the time, and went up to the top where the only exposed contacts are. The first intimation that anything was wrong was conveyed by a scream from the injured man, and on the fitter coming round to the front, he saw his mate lying on the gallery. He jumped down, and with the assistance of the station hands, who were soon on the spot, tried to resuscitate the man, but their efforts were unavailing. A doctor arrived shortly after the accident, but he immediately pronounced life extinct. The deceased had been employed on work of the same kind for about two months, and knew thoroughly the danger of touching anything. Only 15 feet from where the accident occurred a notice was displayed absolutely forbidding anyone to do the very thing which led to the man's death. The pressure was 2,000 volts alternating. No burns or discolouration were noticed either on the skin or clothing of the man, but there was an ugly wound on the back of his head, caused by the fall against the gallery railing.

Electrical Standards — The supplementary and final reports of the Electrical Standards Committee were issued at the end of last week. The final report states that since the date of the former report the Government had been invited by the United States Ambassador in London to take steps to adopt the recommendations of the International Electrical Congress, held at Chicago in 1893. These recommendations, so far as they refer to the units of electrical resistance, electrical current, and electrical pressure, are substantially the same as those suggested for adoption in the committee's previous reports. They see no reason for further delay in the legislation of standards of the above-mentioned units, and they prepared a revised draft Order in Council, which was made an Order in Council on August 23rd last.

The Paris Compressed Air Company and the Clichy Sector.—The Compressed Air Company, after having several times changed its manager, its council of administration, and its chief engineer, and made numerous changes and substitutions in the system of distribution and the mains, could not rest without making further changes in its organisation. The company has been reconstructed on new lines; it is not exactly known on what plan, or what its relations are with the *Disconts Elektricitäts Gesellschaft*, of Berlin, but a new council of administration has been appointed, and amongst its members are M. Lalance, President of the Council of Administration of the Clichy Sector, and M. Journet, engineer-in-chief to the same sector. We have, therefore, good reason to think that the two sectors (the Clichy Sector and the Sector of the Paris Compressed Air Company) are about to be merged into one. But it is not certain that the Municipal Council of Paris will approve of this state of affairs.

The Ealing Central Station.—The lighting of the extremely wide district of Ealing was successfully initiated on Wednesday night. A large number of guests assembled to do honour to the event. The light was formally turned on at the works, after which the visitors proceeded to the Public Buildings, where an electrical exhibition was opened. The visitors were afterwards entertained to dinner at the Lyric Hall by the Local Board. The system adopted is in most respects similar to the one at Derby. Alternating current is employed for incandescent lighting, and the public arc lamps are supplied from continuous current machines. The most notable departure is the partial use of dust destructors for steam raising. Messrs. Siemens Brothers have carried out the chief work of the station, in conjunction with Messrs. Browett & Lindley and the Callender Bitumen Company. The exhibition, which will last ten days, is mainly composed of illustrations of domestic lighting. It should prove a useful object lesson.

Canadian Electrical Association. — The following papers were read at the annual convention at Montreal, on September 19th, 20th, and 21st:—"The Application of Electricity for Medical and Kindred Purposes from Light and Power Circuits," by W. B. Shaw, of Montreal; "Electrolysis," by J. A. Baylis, Bell Telephone Company, Toronto; "Alternating Current Motors," by L. M. Pinolet, of Montreal; "Municipal Electric Lighting," by E. Carl Breithaupt, of Berlin, Ontario; "A Method of Distribution with Equalisation of Potential Difference," by D. H. Keeley, of the Government Telegraph Service, Ottawa; "Possible Reduction of Station Plant on Small Electric Railways by Multiple Series Control of Motors," by John Langton, of Toronto; "The Possibility of Securing better Regulation at Central Light and Power Stations by means of Fly-Wheel Accumulators of Improved Construction," by John Galt, of Toronto; "Telephone Cables, their Construction and Maintenance," by F. J. F. Schwartz, Bell Telephone Company, Montreal; "Duplex Telephony," by T. R. Rosebrugh, School of Practical Science, Toronto; "Electric Brakes," by Elmer A. Sperry, of Cleveland, Ohio. The report of the secretary-treasurer showed that the affairs of the Association were in a flourishing condition, and that the membership numbered nearly 150 members in good standing. It was decided to hold the next annual convention at Ottawa, during the month of September, 1895, the exact date to be fixed by the executive. The election of officers for the ensuing year resulted as follows:—President: K. J. Dunstan, Bell Telephone Company, Toronto; Vice-Presidents: A. B. Smith, Great North-Western Telegraph Company, Toronto, and C. Berkley Powell, Ottawa; Secretary-Treasurer: C. H. Mortimer, *Canadian Electrical News*, Toronto; Executive Committee: G. Black, L. B. MacFarlane, T. R. Rosebrugh, E. C. Breithaupt, John Yule, O. Higman, J. W. Taylor, D. A. Starr, J. J. Wright, and J. A. Kammerer.

NEW COMPANY REGISTERED.

Capsule Battery Company, Limited (42,039).—This company was registered on the 25th inst., with a capital of £30,000, in £1 shares, to acquire patents and patent rights for galvanic batteries of every description, electric call bells, and for, or connected with, brushes or other appliances for the curative application of electricity, and to use electricity and every description of electric or electro-magnetic appliances for every purpose for which the same is available. The subscribers (with one share each) are:—W. P. Teevan, 56, Rodipole Road, Fulham, clerk; F. J. Tummins, 228, Whitehouse Lane, South Norwood, clerk; R. Meggy, Balfour Road, Illford, manager; S. Richards, 25, Beulah Road, Thornton Heath, clerk; J. Gulliver, 2, Lancaster Road, Leytonstone, accountant; H. S. Kean, 87, Goodrish Road, East Dulwich, clerk; G. A. Dallman, 29, St. James's Road, Holloway, clerk. The number of directors shall not be more than five, nor less than three, inclusive of the managing director (if any). Qualification 100 shares. Remuneration £100 per annum, and in addition £200 for every 1 per cent. net profits of the company above 6 per cent. per annum. Registered by Savidge & Southern, 36, Gracechurch Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

British Thomson-Houston, Limited (28,486).—This company (formerly known by the title of Laing, Wharton and Down Construction Syndicate, Limited) filed its yearly return on August 2nd last, which shows that out of a nominal capital of £100,000 in £10 shares, 7,526 shares have been taken up, and that £10 has been called on each of 2,660, £2 10s. on each of 397, and £5 on each of 329 shares. The total sum received is £29,237 10s., and £41,400 has been agreed to be considered as paid.

Field's M.P. Development Association, Limited (34,502).—The last annual return of this company shows that the whole of the nominal capital, £100,000 in £1 shares, has been taken up, and that 85,000 shares have been issued as fully paid. The full amount has been called upon the remaining 15,000 shares, and a total of £14,530 has been received. On August 29th last it was decided to wind up the company voluntarily.

New Electricity Supply Company of Croydon, Limited (37,190).—The statutory return of this company shows that out of a nominal capital of £40,000, in 100 founders' and 7,900 ordinary shares, all of £5 each, 29 founders' shares have been taken up.

D. Hulett & Co., Limited (29,463).—This company's annual return, filed on the 13th ult., shows that out of a nominal capital of £35,000 in 6,900 ordinary and 100 founders' shares, all of £5 each, 100 founders' and 5,900 ordinary shares have been taken up, and that the full amount (£9,500) has been called and paid on 1,900 shares. A sum of £20,500 has been agreed to be considered as paid.

Ipswich Electricity Supply Company, Limited (31,833).—Mr. R. Aitken, M.Inst.C.E., late chairman of the above-named concern, has written to the Registrar of Joint Stock Companies, stating that it has ceased to exist.

Islington and General Electric Supply, Limited (31,844).—Mr. V. B. D. Cooper, of 5, Victoria Street, E.C., writes the Registrar of Joint Stock Companies to the effect that the above concern has ceased to exist, owing to its having failed to obtain the necessary capital.

THE ELECTRIC MOTOR AND SOME OF ITS APPLICATIONS.

In our investigations into the manifold uses of the electric motor, we have, for the most part, confined ourselves to the various applications that have been made in this country. Not that we have in this short account noted all the uses to which electric motive power has been applied, for there are numerous instances of the employment of motors which we should like to have dwelt upon, but the lack of time and opportunity precludes more than a passing reference.

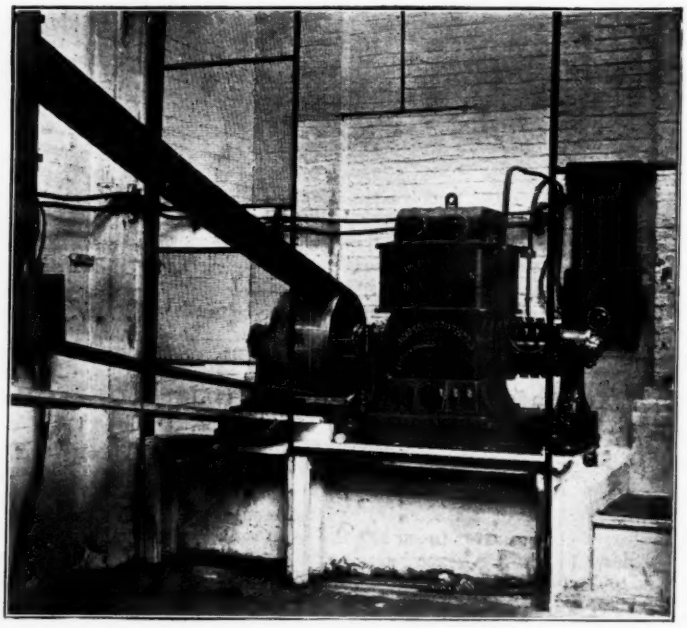
When we took upon ourselves the task of enquiring into the applications of electric motors in this country, we did so under the distinct impression that they were comparatively little known, and by no means altogether appreciated. We were fully aware that there were central stations which had the good fortune, or otherwise, to have motors upon their circuits, and we were cognisant of a few isolated examples of the use of motors driven from private plants, but we had not the faintest notion of the varied uses to which they had been applied. On the score of numbers, the total used over the entire country cannot be considered excessive, but it has been to us a most satisfactory and pleasing feature to find the electric motor pushing its way into all sorts of curious industries, and exhibiting its marvellous flexibility under all kinds of strange conditions. The electric motor is to-day driving mineral trains in the lead mines of Westmoreland, it has usurped the direct use of steam in Midland flour mills, it has penetrated into sweet and cleanly Essex dairies, it is turning the heavy machinery of rubber factories, it is driving rag-picking machinery, it is opening dock gates, driving cranes, band saws, blowing organs, and actuating the poor man's lathe. Its use in collieries for pumping, winding, and drawing would need almost a special treatise. We have been specially impressed with the use of the motor in the humble capacity of turning the lathe of the small master mechanic. To our minds this was one of the most interesting applications that we had the good fortune to see. Whether or not we shall reach, by the aid of the motor, the happy picture foreshadowed by Lord Salisbury, when the disruption of families now so necessary by work-a-day life will be obviated we cannot say, but it does seem reasonable to assume that the extended use of the motor may tell against the great aggregation of human beings, which is one weak spot in our latter day civilisation.

It is scarcely necessary for us to dwell upon the many advantages that motors offer, but it is interesting to record the opinion of many of those who, impressed with its adaptability, its cleanliness, and its noiselessness, have become ardent advocates for its use. As a matter of fact, those who are most enthusiastic of the advantages of electric motors are not electrical engineers, but the people who use them. Engineers long ago saw that the motor was bound to displace the uneconomical small steam engine with its 15 lbs. of coal per H.P. hour. Doubtless the most powerful rival of electricity for small power purpose is the gas or oil engine. It goes without saying that such engines can be used where electric motors would be quite out of the question, but it must also be borne in mind that in many respects the motor can give points to them. We have, indeed, met with more than one instance where gas engines have been displaced by electric motors. These are cases, however, where the motive power used is small. Leaving the small motors for further consideration, we will turn our attention to the cases where motors have been used on a large scale.

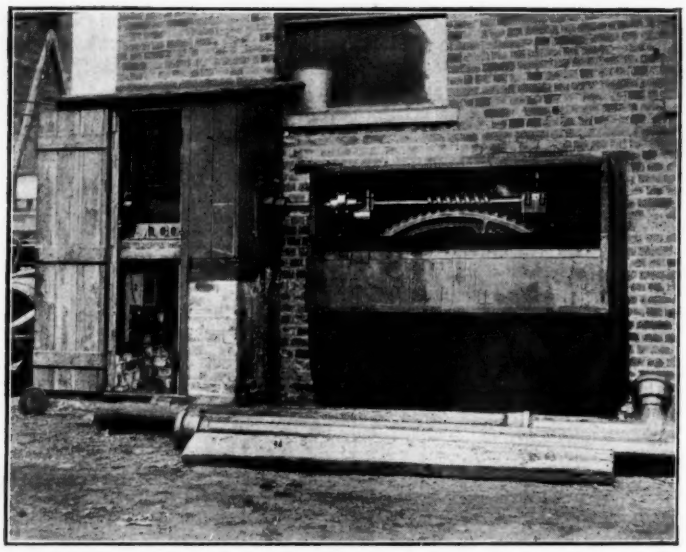
The Use of Large Power Motors.

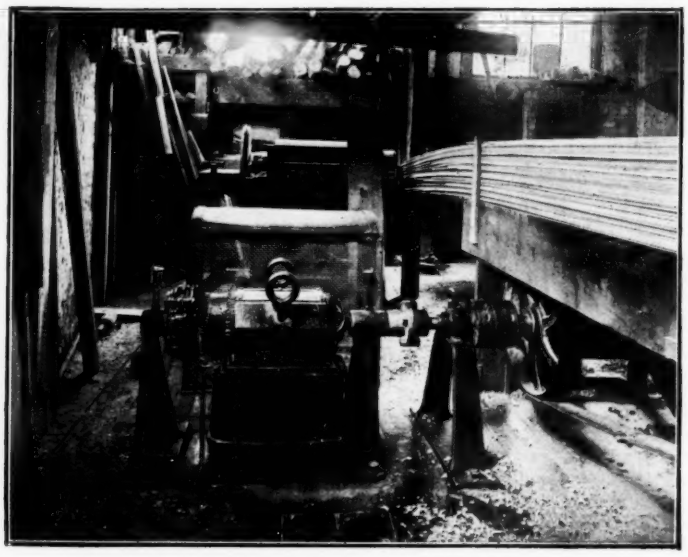
The most conspicuous and perhaps the best known example of the use of large and powerful motors is to be found at Messrs. Siemens Brothers' factory at Woolwich. Electric motors, varying from 1 or 2 H.P. up to 40, are supplying power, almost, if not quite, throughout the works. By the courtesy of Messrs. Siemens we are enabled to illustrate some of the most typical instances. The advantages of space saving which accrue to the use of motors have been fully realised at Woolwich. The workshop operations at Messrs. Siemens's are carried on in many different buildings which cover probably some four acres of ground. Each building practically demanded its own power plant, nearly every department having its own engine, and very often its own steam raising plant. It is not necessary to dwell upon the fact that such an arrangement needed quite an army of stokers and engine drivers, whose time might or might not be fully utilised. When, however, it became a settled conviction that extensions of premises were essential, it was resolved to make a radical departure and substitute electric motors for the steam plant. The step was in reality a bolder one than it might at first sight appear to be, for it practically meant the complete abandonment of good working steam engines and boilers which would be either placed on the scrap heap, or sold at little better rates than old iron. This is perhaps the one serious objection to the adoption by manufacturers of electric motors. Of course, when it becomes necessary to make extensions of buildings, and it is essential to increase one's power, then comes the time when the question of electric motive power can be fairly considered. Messrs. Siemens were apparently satisfied that the substitution of electric motors for comparatively new steam plant would be eventually justified. Unfortunately we are unable to put before our readers any notion of the comparative economy that has been effected at Woolwich. We understand, however, that Mr. Alexander Siemens contemplates reading a paper on the subject before one of the learned societies shortly, and no doubt it will be an important addition to our knowledge. Compelled as we are to speak only of the general use of motors, we will pass on to consider some of the most striking examples. At the Woolwich factory electric motors are supplying power sometimes by driving shafting to which a group of machines are connected by belting, for even with motors we have not got rid of all the losses due to mechanical transmission, at others by being coupled direct to the moving mechanism. One of the best instances of a motor driving shafting, shown in one of our illustrations, is in the electric light cable shop where a motor of 40 horse-power is driving eight lines of shafting. The saving of space effected may be gathered from the fact that the motor occupies a space in a corner of the room of 10 feet by 5, whereas the engine which has been supplanted filled a space 30 feet by 13. The ease with which the motor adapts itself to all conditions is shown in the wire-winding shop, where the motor is placed on a platform several feet above the ground, from whence it drives a double line of shafting. The chemical department derives its power from a motor actuating worm gearing. This example is interesting because the gearing, as will be seen in one of our illustrations, is placed outside the building. The motor is enclosed in a wooden box, while the gearing runs in oil contained in an iron case. There are a few motors in the carpenters' shops driving planing and sawing machines; the most noticeable is the driving of what is termed a general joiner, which contains tools for sawing, cutting, planing, and grooving. It takes at times considerable power, the average ampèrage being 25, though it occasionally takes 50. The use of the motors are too numerous and various to be noticed in detail. The main machine shop, where the heaviest work is done, requires three large motors to drive the shafting, two of 40 H.P. and one of 20 H.P. The machines are grouped together in a corner of the shop and take up surprisingly little space. Then there are motors driving blowers in the smiths' shop and planing machines in the fitters' shops actuated by the same means. In the submarine cable department and in the India-rubber mills, motors are in some cases driving one, in other cases two machines. We give illustrations of both these. The case of the callendering rooms in the India-rubber mills is a good instance of the flexibility and economy of electric motive power. Each of the large callendering machines has its own motor, and the wisdom of such an arrangement is beyond question, for it often happens that some of the machines, which are particularly heavy, have a long spell of idleness. In this instance it would be most uneconomical to be obliged to run heavy shafting for a small proportion of the machinery. It is perfectly clear that Messrs. Siemens have derived to the fullest extent the great advantages offered by electric transmission; they have saved valuable spaces formerly occupied by steam engines, and they have abolished to a great extent the losses due to mechanical transmission. The concentration of the whole of the steam plant in one compact space has led to great saving in labour, the majority of the men who formerly attended to the scattered steam plant being drafted on to other

Motor in Electric Light Cable Shop.



Motor Driving Shafting in Chemical Department.





Motor in Carpenters' Shop Driving General Joiner.

work. It should also be pointed out that large compound and condensing engines are used with consequent economy. The central station which supplies the power has a capacity of 1,500 H.P.; there are three Willans and Siemens's sets of 300 H.P. each, and a Belliss and Siemens's set of similar horse-power.

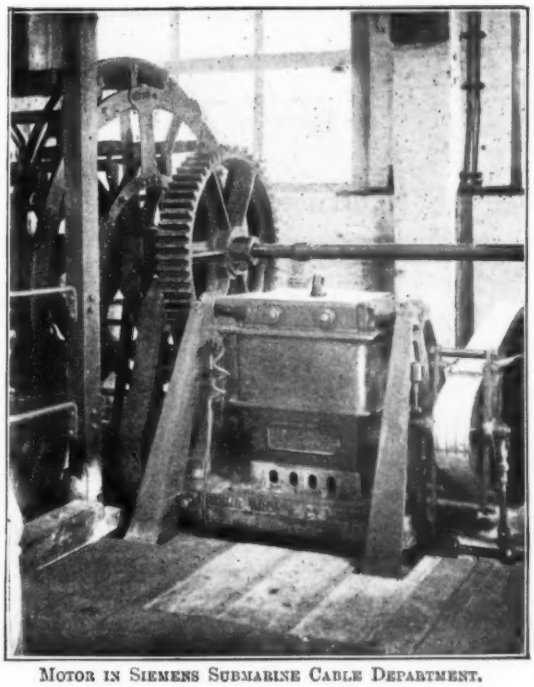
Another of the largest and most important applications of electricity for driving purposes is at Messrs. Howard and Bullough's, Accrington. This firm has a world-wide reputation as makers of cotton spinning machinery. Like so many other enterprises in the north, the business of this firm has grown until it has reached almost colossal proportions. Consequent on its growth, the firm has been compelled to add new buildings until the works cover a very extensive area. The uneconomical results of scattered steam plants have been, perhaps, more accentuated in this case than in that of Messrs. Siemens. The work in some of the departments goes on night and day, and the losses from mechanical transmission is a continuous one. It was when considering the advisability of introducing some reforms in this direction, that the management had the advantages of electricity extolled to them. After careful inspection of the one or two existing instances of motor practice, and a minute enquiry into cost, it was decided as a preliminary step to put down a set of 10 motors of 10 H.P. each. During a recent visit to Lancashire we had the privilege of seeing them at work; we were then assured that the experiment had been so completely convincing that it had been resolved to fully equip new workshops, then in course of erection, with electric motive power. The central station is at the moment of only modest dimensions, but it will soon be necessary to increase the power, if the necessity has not already arisen. There were at the time of our visit two Elwell-Parker dynamos (110 volts 450 ampères) driven from shafting by a Musgrave engine. In the fitting shop, a line of shafting traversing the length of the room is driven by three motors, one at each end of the shaft and one in the middle. The machines are driven from this shafting by belts. This shop had been working night and day for two months, the motors being in constant use during this period; they seemed, however, to be very little the worse for their extraordinarily long run. Leaving this department we passed on to the dressing shop. Work was in full swing and the noise was terrific. The dressing machine is simply a revolving iron box, in which small castings are vigorously shaken until their roughness is worn down. On the occasion of our visit twelve dressing machines were at full shake, driven from shafting actuated by two motors. The weight of the castings dressed in one week in this department is 300 tons. On our way to the casting shop we pass the hoist which is driven by an electric motor. The only thing of electrical interest in the casting shop is the heavy cranes which are driven by electricity. A visit to the cylinder shop where huge cylinders are turned, the shafting here being driven by motors, completed our tour of inspection.

The fact that Messrs. Howard & Bullough have resolved to adopt electricity for power purposes in their new workshops is of the utmost significance. It is perhaps the only instance at the present moment of a real and independent trial of electric motive power on a large scale. We are not forgetting what has been done in electric transmission at Siemens's and at the Electric Construction Company's works, but, however well these

systems have served their purpose, they must to some extent be considered show plants.

At the Accrington Mills there will doubtless be a gradual but complete abandonment of isolated steam plants, for the proprietors are completely alive to the manifold advantages of concentrating steam raisers. It is yet too early to expect detailed costs of working, but there appears to be the greatest satisfaction with the general performance of the electric machinery, and a settled conviction that it is the only system which can efficiently supply power to scattered buildings.

Motor in Siemens Wire Winding Shop.



Motor in Siemens Submarine Cable Department.

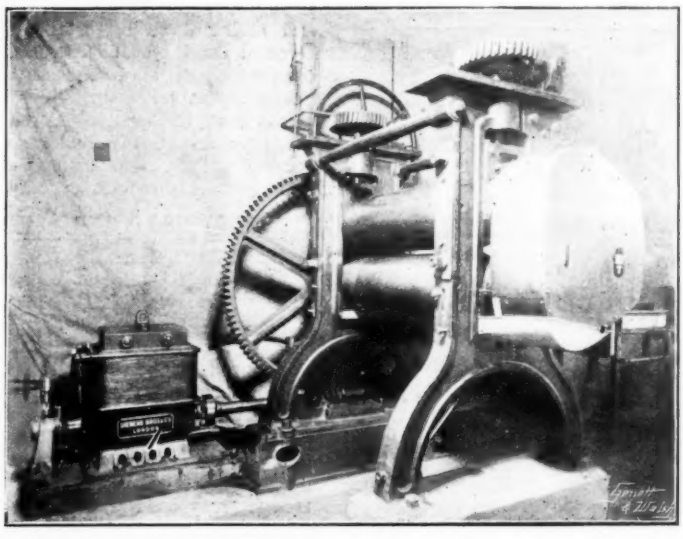
Isolated Motor Plants.

We now come to consider isolated motor plants. By isolated motor plants we mean cases where only one or two motors are used. It is in this direction that the greatest activity has prevailed in motor work in Great Britain.

One of the oldest instances in this country of this class of work was carried out some seven or eight years ago by Messrs. Mather & Platt at a Croxley paper mill, near Watford. Dynamo machinery was laid down for lighting purposes, and, in addition, two motors were fixed for driving a bleaching plant, and another driving shafting in a rag tearing and sorting room. These have continued to work down to the present day with the utmost regularity and freedom from trouble.

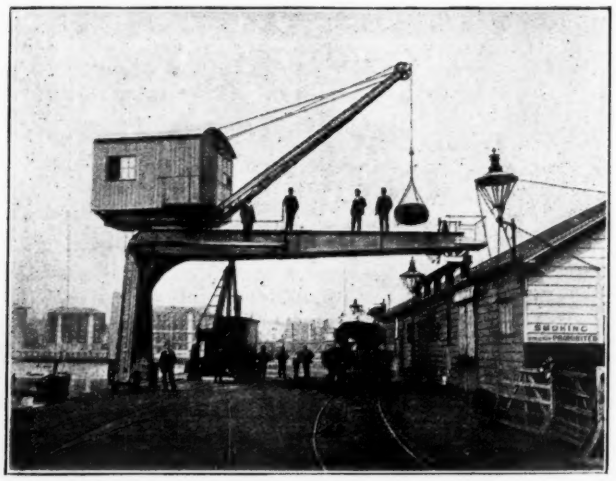
An instance of a small transmission scheme, some 20 horse-power or so, was carried out by Messrs. Laurence, Scott and Co., at the Anglo-Bavarian Brewery, Shepton Mallet. In this case the motors are employed for pumping water three-quarters of a mile from the brewery.

The case of the motors driving the Southampton cranes will be, to many of our readers, a familiar one, in fact we have already published some details; we cannot, however, omit to refer to it again in this article. There are two cranes working at the present moment, and they have been in constant use for six months and have worked satisfactorily. It will be seen from our illustration that the cranes are mounted on a traversing gantry, which allows the passage of the traffic of two lines of railways in addition to vehicular traffic. The cranes are of the jib type with slewing and derricking motions, the radius of the one being 27 feet 6 inches, and of the other 32 feet 6 inches. Each crane lifts a maximum load of three tons at a vertical speed of 100 feet a minute, or a load of two tons at 200 feet per minute, with a slewing speed of 500 feet per minute. The lifting and slewing motors in each crane are operated by independent motors. The lifting motor absorbs 160 ampères at 200 volts when lifting the full load of two tons at 200 feet per minute. The slewing motor absorbs 20 ampères when slewing at full speed with a load on the jib. The switch gear operating the two motors is constructed on what may be termed the commutator principle, that is to say, the segments used as contacts are separated from one another by mica and held in position by screw pressure. They are pressed upon by a flexible brush, and are mounted upon slate bases enclosed in teak boxes. The operating handles are substantial levers, 3 feet 2 inches in length, provided with quadrants and notched catches. The forward movement of the lever starts the lifting motor, and with the slewing motor a forward movement corresponds to the slew in one direction, and the backward movement to a slew in the reverse direction. When both levers are vertical, the motors are at rest. The motion of the motors is transmitted to the crane gearing by means of cut worms working in oil baths,



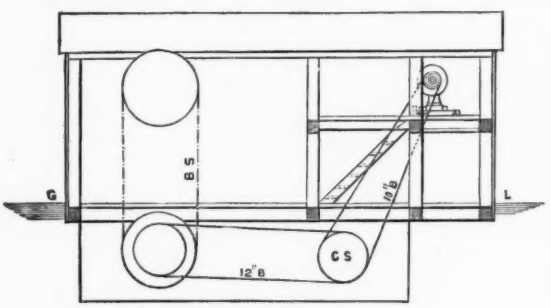
Calendering Machine at Siemens's.

with a liberal allowance of surface. It is claimed that the arrangement has an efficiency of 70 to 75 per cent. The foregoing was carried out by Messrs. Statter & Co. By the courtesy of this firm we are enabled to show the arrangement of a 30 horse motor driving a band saw, which has been constructed for the Gloucester Wagon Company, in accordance with plans of Mr. W. A. Walton, electrician to the Wagon Company. The motor receives 110 volts at the terminals,

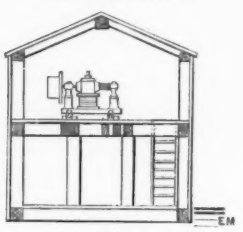


One of the Southampton Cranes.

and absorbs 230 ampères at full load. A fly-wheel is fixed on the motor. This plant was put to work in the spring of '92, and has worked satisfactorily since without needing repairs of any kind. The saw is used for splitting large logs, which it is needless to add, is particularly heavy work. The Wagon Company apparently believe in the possibility of the electric motor, for it has been applied by them to capstans. We give an illustration of one which has been supplied by Messrs. Crompton.



Longitudinal section.

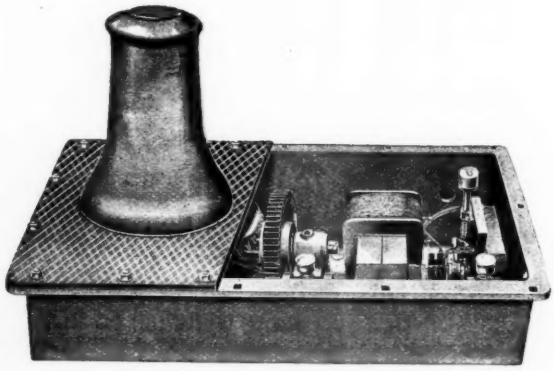


Section.

E M Electric mains; G L, Ground line; B S, Band saw; C S, Counter shaft.

Band Saw driven by Motor.

Before leaving finally the subject of cranes and lifting apparatus, we would refer to one or two cases of electric travellers. At the present moment the West India Dock Company have three travellers worked by electricity. Each traveller lifts 6 tons at 10 feet per minute, or 3 tons at 20 feet per minute. The cross traverse is at the rate of 60 feet per minute, and the longitudinal traverse 80 feet per minute. The whole of the motions are taken from one motor which is mounted on the crab and enclosed in a casing. The capacity of the motor is 100 volts and 40 ampères, and the revolutions 900 per minute. It is kept continuously running while the traveller is at work, and is controlled by starting gear on a driving platform. The various motions required are operated by means of friction clutches. These cranes were put to work by Messrs. Statter & Co., in the autumn of '93, and they have given complete satisfaction. Electric cranes are used by the Government at the Woolwich Arsenal. Those illustrated by us have been supplied by the Acme & Immisch Electric Works.



Electrical Capstan used by Gloucester Wagon Company.

A very good instance of the flexibility of electric motor plants and the little attention they require is at the Quartertown Flour Mills.

The machinery was started in the spring of '91 and has been in constant operation ever since. As a rule, the machines run continuously day and night and are attended to by an ordinary engine driver. An interesting feature of the work is that the power is obtained from a waterfall situated a quarter of a mile away from the mill. The generator gives 640 volts and a constant current of 60 ampères at 900 revolutions per minute. The motor absorbs a varying voltage according to the load, rising to 610 as a maximum and falling down below 200 with lighter loads, with a constant current of 60 ampères. The machine is kept at constant speed by means of a centrifugal governor enclosed in an oil bath. This is shown attached to the pedestal of the commutator end bearing, and it controls the positions of the brushes in the commutator. The brushes of the generator are similarly controlled by a regulator, sensitive to current only. The revolutions of this machine are not absolutely constant as the speed of the water-wheel varies with different loads. This is a matter of no importance since the regulator maintains the current constant at 60 ampéres irrespective of other conditions, provided the speed is sufficient to maintain the full 640 volts. The system is the Statter-Brunton patent constant current system, which has been applied with success to this and other installations in which the distance between generator and motor is too great to admit of the use of parallel working machines, where regularity of speed at the motor is an essential.

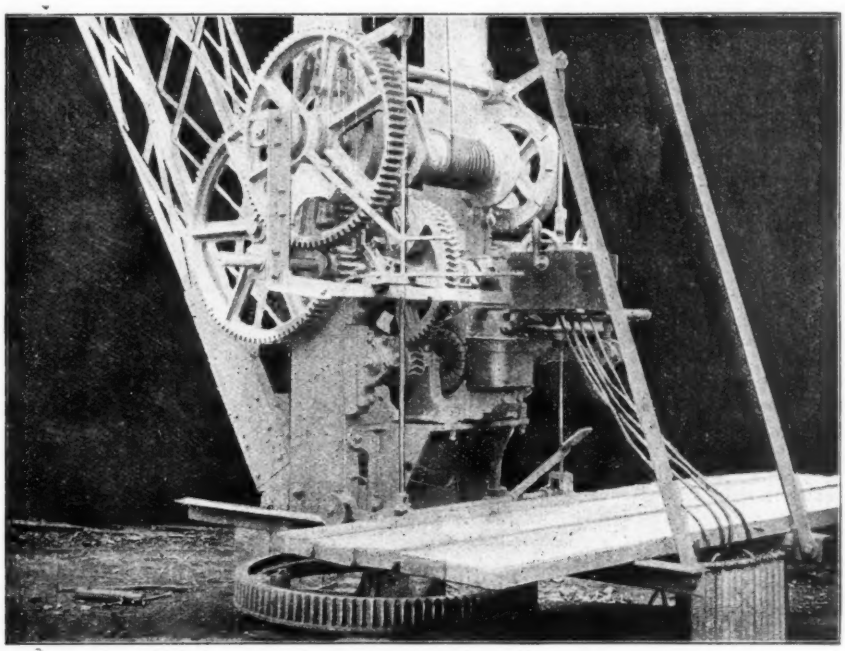
We believe that one of the earliest applications of electric motors was for the purpose of organ blowing, and there are several cases in this country of such use being made of electricity. A typical instance was one carried out by Messrs. Box and Co., in conjunction with Messrs. Statter and Co. The motor is only a small one developing about 1 horse-power. It is run at an E.M.F. of 100 volts and 10 ampères, and has a speed of 1,300 revolutions per minute. It is geared through an intermediate shaft to the blower shaft, which revolves at 80 revolutions per minute. It is controlled by an automatic switch worked off the bellows, which allows the motor to run at its full speed without the interposition of resistances when the wind chest is being drawn upon for a large supply for the organ. Just before the wind chest is completely filled, the switch is thrown by a snap action on to an intermediate contact and the motor slowed down to less than half speed. From this it is gradually shut off through a dashpot. On the wind chest falling, the motor is again switched on through the intermediate resistances and immediately afterwards fully on.

We had originally designed to speak of an application of electric motive power at Messrs. Campbell's clothing factory at Leeds, under the heading of the use of small motors, but insomuch as the total power is fairly large, it ought, perhaps, to be considered here. This factory was the first in the Leeds district to be entirely lighted and driven by electricity. Power was laid down for 600 sewing machines, the first instalment of 300 having been running for nearly three years. The sewing machines are driven by bands from shafting which passes under the floor. Space has been designedly left between the floor and the ceiling of the floor beneath for shafting and motors. There are four motors each of 6 H.P. actual, each one driving three lines of shafting, there being an average of 25 machines on each shaft. The sewing machines make on an average about 1,200 stitches per minute. There are two cloth cutting band saws which are driven by a 6 horse-power motor. The power is obtained from four Kennedy dynamos driven by Proell engines.

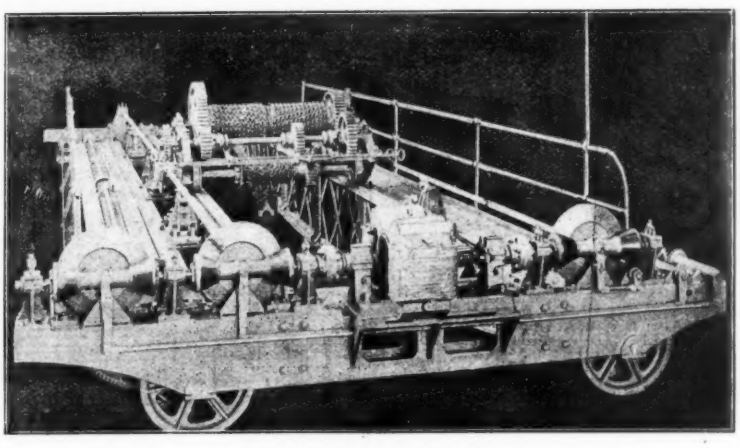
There is a special feature about this use of electric motive power at Messrs. Campbell's factory which is deserving of some comment. The factory was built with a view to electrical driving, and on that account is of much lighter construction than is usual. The result of this lighter building is a considerable economy in the cost; it was computed that £2,000 was saved in building alone by adopting electric motive power. A great advantage also is that there is practically no moving machinery, a valuable consideration where numerous girls are constantly moving about.

It is interesting to note that before building operations were commenced, specifications were asked for steam plant with ordinary shafting and belting, as well as an electrical scheme. The first cost was about equal, but electricity offered distinct advantages, in that a cheaper kind of building was only necessary.

It will have been noticed that the sewing machines are driven from shafting and not separately from single motors. This is contrary to the general American practice, but Messrs. Campbell's factory is a case where it would have been quite out of the question to employ a motor for each machine. We are assured by an American writer who has investigated the use of small motors, that it has been found cheaper to use motors attached to each machine. This may be so in the instances the writer has in mind, but it does appear to be clearly established that the use of small motors becomes impracticable after a certain number is employed. It may be that the actual consumption of current is less for a number of small motors than when shafting is employed, for the separate motors gain when the sewing machines are at rest. On the other hand, the motor driving the shafting may be absorbing more current, but it is certainly working at a greater efficiency than the small motors. For the purpose of argument we will take a simple case. Where 30 motors are driving 30 sewing machines, they cannot well be less than $\frac{1}{8}$th H.P., now, we cannot, on a most liberal estimate, expect to get a higher efficiency than 60 per cent. from each of these machines, in fact, this figure was arrived at by some of our friends in recent tests on small motors. This 60 per cent. efficiency must be compared with the 85 or 90 per cent. efficiency of a large motor, for any manufacturer will guarantee this for a motor above 3 H.P. Without going into the question as to how this efficiency would affect the result, we will compare the original cost. A six horse-power motor to drive 30 sewing machines would cost approximately £50; 30 $\frac{1}{8}$th-H.P. motors would cost roughly £7 10s. each, the total expenditure being £225. If we agree to leave out the cost of shafting in the one-motor case as being fairly well balanced by the cost of wiring and switches for the small motors, we practically have the small motors costing nearly £175 more than the large one. Now it can be fairly well maintained that such an increased cost would never be recovered during the life of the motors by a greater economy in current. But the one strong point against the multiplicity of small motors is the extraordinary large amount of attention and maintenance which they would require. It must not be for a moment understood that this is written in condemnation of the small motor, for we shall presently have a good deal to say in its favour. Our only point is, that under the

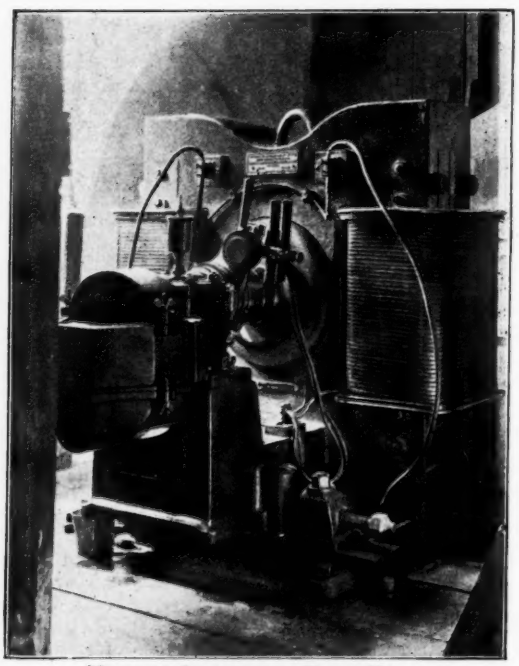


Electric Jib Crane.



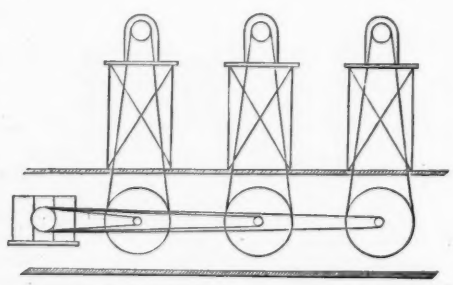
Electric Travelling Crane.

circumstances above related, it is more economical to use motor and shafting than to use single motors. A similar case to our typical one is that of Messrs. Hodges & Todd, of Hampstead Road, who use a 4 H.P. motor to drive by shafting about a dozen lathes arranged on two floors. Assuming that half of those lathes stand idle for the greater part of a day, it would still be more economical to use the present arrangement of shafting than to employ a small motor for each lathe. Of course we soon reach a point when it is more economical to attach a motor to a machine in a similar manner to that done at Siemens's. It is interesting to note, in connection with Messrs. Hodges & Todd, that the motor has supplanted a gas engine. Although no comparisons have been made, we are assured that they feel confident of the economy which has been effected by the electric motor.



Motor at Quartertown Flour Mills.

A striking application of the electric motor has been made by Mr. Blyth, of Blythwood, Essex, in his private dairy. The special conditions which are absolutely essential to the well-being of a dairy precludes almost every kind of power except hydraulic and electricity. Generally speaking, the former is out of the question by reason of its inaccessibility. Signal success has attended Mr. Blyth's introduction of electric motors into the dairy. A Lister's "Alexandra" separator, in addition to a Bradford churn, is driven by an electric



Arrangement of Sewing Machines at Messrs. Campbell's.

motor. The arrangement is distinctly neat and works exceedingly well. Electric motors are used in the house for domestic purpose and the electric light is laid all over the estate. The entire work has been done by Messrs. Pritchett and Gold.

Closely akin to electric dairy work is the use of electricity on the farm. There are now two or three farms in various parts of the country which are using electricity in some form or other for power purposes. Probably the first farm in this country, or, at any rate, in Scotland, to utilise electric motive power is at Ardwell in Wigtonshire, where an electric motor has been employed for a considerable period driving threshing and cutting machines.

An interesting scheme has been carried out for the Monastery at Fort Augustus, where water-power has been utilised to turn a dynamo which supplies power for lighting and motor work. The particular application of the motor in this instance is for driving a crane which is used in the building of the large new church. The motor is specially suitable for the class of work required, the crane being used intermittently, in fact, many days often elapsing without it being used. The chief reason for this occasional use is that the building is carried on very slowly, it being expected that the church will take several years to build. It might be mentioned that the water-power is some distance from the monastery, the energy being transmitted by an overhead wire. Besides supplying current to the monastery, the water-power plant lights a house at Cullachy, about a mile and a-half distant. It is intended to tap the wires at Ardachy, a farm midway, and to place thereon an electric motor for driving farm machinery. The motive power will be specially used in connection with a cream separator.

We ought to have mentioned, when speaking of Ardwell, that pumping is done by electricity. The pump is an ordinary force one; it formerly required the work of two men for several hours per day to provide the necessary water supply. This pump being reciprocating, it was necessary to work it by means of an eccentric on an overhead countershaft, this shaft being driven by a belt from the motor. In order to equalise the pull of the up and down strokes, Mr. Yorke, who carried out this as well as the Fort Augustus schemes, arranged a balance weight which is attached to the pump rod by a cord running over a small wooden pulley. This balance weight works up and down, easing the motor on the upstroke and giving it work to do on the down, thereby rendering the load on the motor more regular.

(*To be continued.*)

THE ELECTRIC LIGHTING OF HAMPSTEAD.

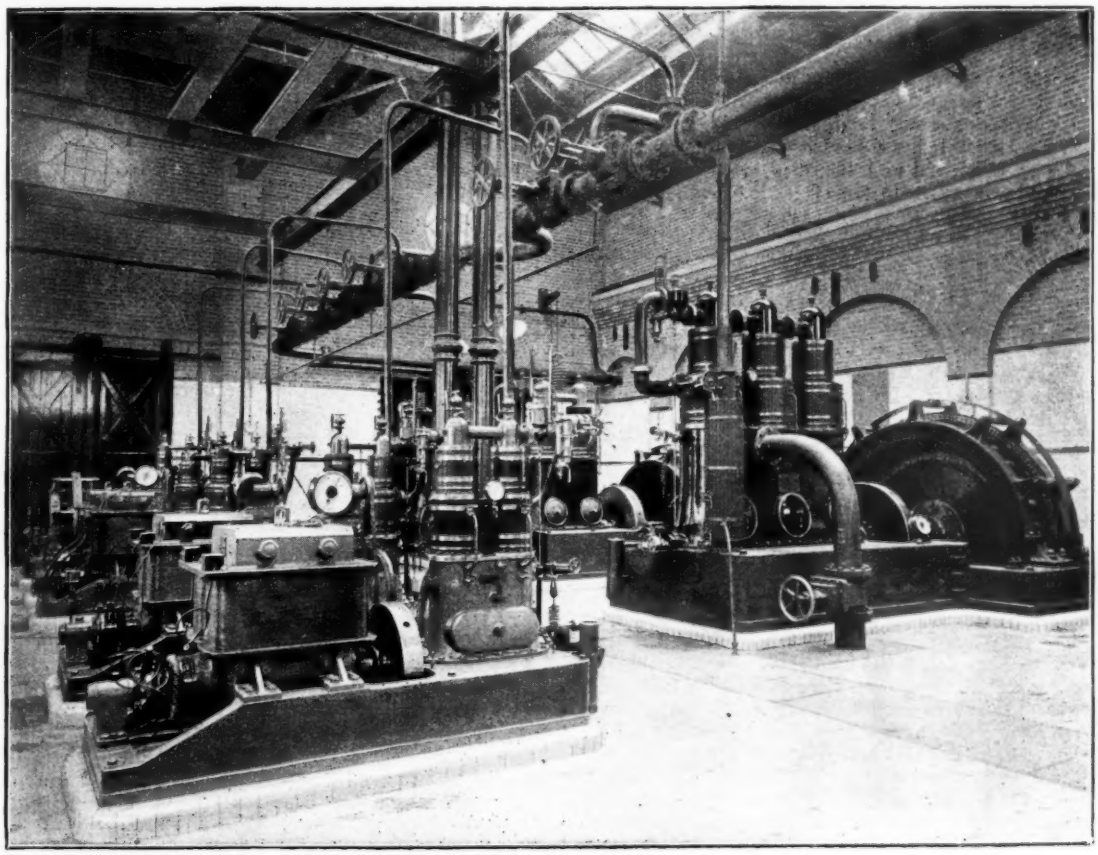
The Hampstead Vestry has gained the distinction by a few days of being the first suburban authority in the Metropolis to introduce a public supply of electricity. When it is considered how conservative London vestries have been, however, in the matter of electric lighting, it is perhaps not a great honour. Still we have nothing but congratulations to offer to the northern suburb on the inauguration of its public supply, which took place last Monday night.

The Hampstead Station is essentially modern. It is replete with all the improvements which 10 years' practice has produced. It is provided with direct coupled alternators, and with coal elevators and conveyors.

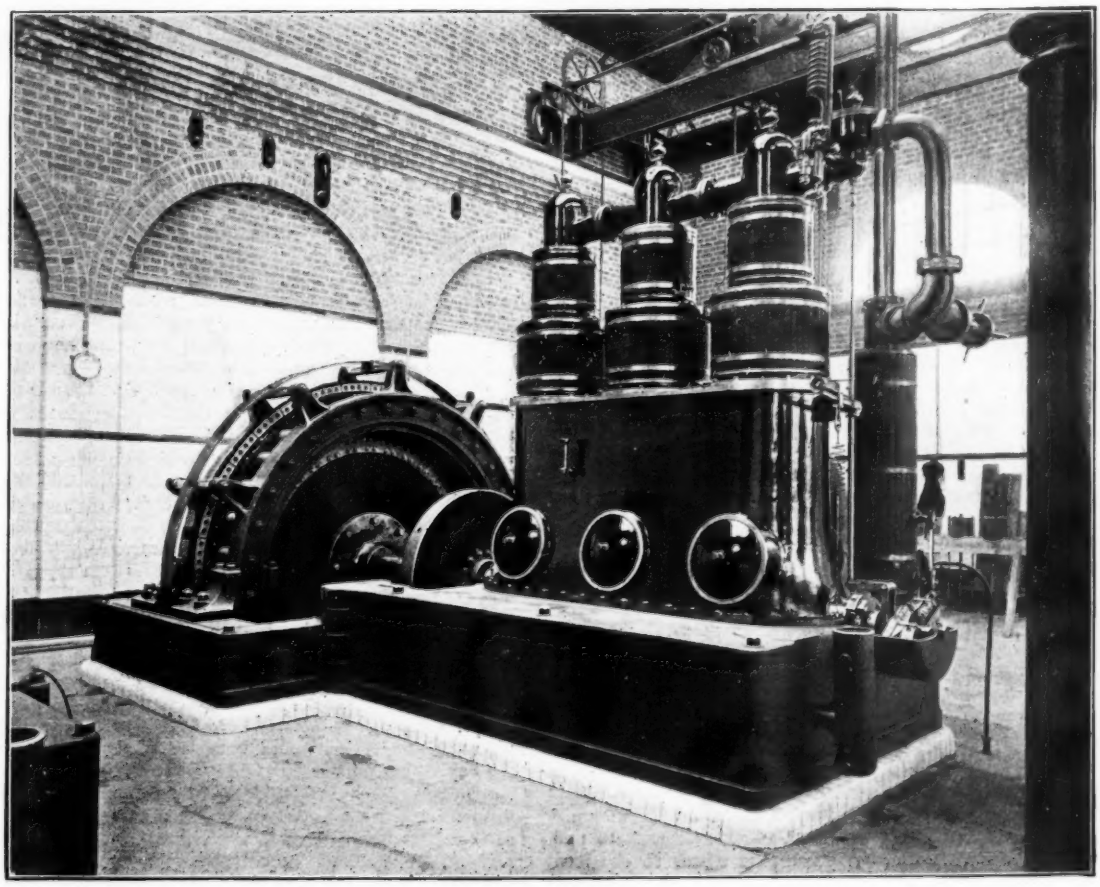
The early history of the undertaking is much the same as others. There were the favourable recommendations of a committee which had gone carefully into the matter discounted by the Vestry, which, as a body, knew nothing of the subject. Still the Electric Lighting Committee, under the chairmanship of Mr. Thwaites, were not content to let the matter rest, and after much urging the Vestry reconsidered the matter, and finally decided to obtain a report from an expert. After receiving a report from Mr. W. H. Preece, the Vestry applied for a provisional order, and in December, 1892, they determined to undertake the supply, and applied to the London County Council for permisson to borrow £25,000 upon the security of the rates.

Competition in the District.

The central station erected by the Vestry is by no means the first in the neighbourhood, for less than 100 yards away stands a modest, but by no means despicable rival to the favours of the public. This station, which has done useful service for the past few years without attracting much notice, is owned by the Hampstead Battery Company. At the



Interior of Station.



Engine Alternator.

present moment this company supplies current to the principal shops in the neighbourhood, and to a fair number of residences, the total number of lamps connected approximating to about 6,000 8 C.P. This company, in spite of its competition with a strong local authority, is by no means in a weak position. It has a good *clientele*, or, we should say, a good connection, and we believe that most of its customers have signed agreements to the effect that they will continue to take current from the Battery Company for a definite period. We are not sure what term has been specified, but are satisfied that it exceeds 12 months. It will be seen, therefore, that the Vestry will be to some extent handicapped in their early efforts. We are not prepared to say what the future may suggest in the way of arrangement, but it is not to be expected that a long continuance of competition will be favourable to both.

Leaving this phase of the Hampstead lighting question for possible future consideration, we will turn to the station itself.

The Generating Station.

The system is a high pressure alternating one of 2,000 volts. The generating station has been built on a portion of the Vestry's stoneyard, which is situate off the Finchley Road.

The buildings consist of an engine room built in two spans, one of 26 feet and the other of 16 feet, the size of the engine room is 58 feet by 42 feet by 23 feet high, and it is large enough to accommodate a 50 per cent. increase in the glow and arc lighting machinery. The boiler house is covered by one roof, having a span of 43 feet; it is 58 feet long and 24 feet 6 inches high, its floor is 9 feet below that of the engine room, which is on the ground level, thus allowing space for coal bunkers under the roadway; these bunkers will hold 100 tons of coal. Complete and separate lavatory accommodation is provided for the engine room and boiler house staff. The chimney is 130 feet high and 8 feet internal diameter; up to a height of 50 feet it is divided into two compartments only, one of which is used with the present boiler plant, the other half being provided for extensions.

The offices are complete, consisting of engineer's office, clerk's office, stores and testing room. Separate lavatory accommodation is also provided.

There are four boilers of the Lancashire type, each boiler being 28 feet long by 8 feet diameter, and is guaranteed to evaporate 5,000 lbs. of water an hour at a pressure of 150 lbs. per square inch. The material used throughout is Siemens-Martin steel, and each boiler has been tested to a pressure of 250 lbs. per square inch; the usual fittings are provided, and include two safety valves, duplicate feed-water check valves, and mechanical stokers. Coal is supplied to the stokers by a coal elevator, consisting of an endless chain and buckets working in a sheet steel case, and a conveyor consisting of a worm working in a trough, from which the coal falls through shoots, placed at necessary intervals, into the stoker hoppers.

The stoking machinery is worked by a small vertical engine, provided in duplicate, and the whole is arranged with clutches, loose pulleys, and striking gear, so as to be completely under control, and so that the breakdown of any portion of the machinery cannot interfere with the working of the station.

There is a complete duplicate service of feed water to each boiler, a supply being obtained from the water company's mains, and also from a storage tank having a capacity of 10,000 gallons; there are two Worthington feed pumps, each of which can supply water to any or all of the boilers, independently of the other. The feed water is heated by an exhaust steam heater, and also by a Green's economiser of 192 pipes, placed in the main flue; each heater is provided with a bye-pass, and each can be used together with, or independently of, the other.

Steam is taken from the boilers to the engines in a wrought-iron ring main divided by valves placed between each engine and each boiler, into sections, each section being drained. A small auxiliary steam ring, connected to two sections of the main steam ring, supplies steam to the feed water pumps and stoker engines.

The exhaust steam is carried to the atmosphere 50 feet above the ground level through a cast-iron exhaust pipe.

The Dynamo Room.

The dynamo room, which we illustrate, contains the following steam dynamos, erected on solid concrete foundations, finished off with a plinth of glazed brick.

For Incandescence Lighting.

1 200-kw. steam alternator supplying 5,700 8-C.P. lamps.
2 100 „ „ „ each „ 2,850 „ „
1 20 „ „ „ „ 570 „ „

The large steam alternator, of which we give an illustration, is the most striking feature of the station.

For Arc Lighting.

2 13-kw. steam dynamos, supplying 22 2,000-C.P. arcs; and for exciting the above, and for station lighting, one 18-kw. steam dynamo.

The engines are of the Willans compound, and the dynamos of the Siemens type, and are in all cases direct coupled.

The current is taken from these dynamos to the station switchboard, which is built up of polished slate panels, one panel being provided for each dynamo, and one for each circuit. Through these panels the alternators are connected by omnibus bars to the circuits, and are arranged to work in parallel, a synchronising panel being provided for the purpose.

Each panel is provided with the necessary instruments for measuring the current and E.M.F., and the whole of the switchboard is mounted in a polished teak frame, and is railed off from the engine-room.

The incandescent lighting current, at a pressure of 2,000 volts, is taken from the main switchboard by high tension feeder cables to seven sub-stations, each of which supplies a small area, all seven sub-stations being connected by low pressure distributing mains.

The feeders are Siemens H.C.N. type, protected with iron armour insulated with special fibrous material cased in lead, and are connected in the sub-stations to Siemens transformers, which transform from 2,000 to 105 volts, at which pressure customers are supplied with current from low tension mains similar to the high tension mains, but not so highly insulated.

The sub-stations are small brick chambers, 6 feet × 5 feet, and are built under the pavement, access being obtained through a small manhole in the top.

Each sub-station contains two 25-kw. transformers, a high tension fuse board and a low tension switchboard, from which the distributing mains are taken, and so arranged that the supply to any length of distributing main between two sub-stations can be cut off, for the purpose of connecting customers, without interfering with any other part of the system.

Each sub-station will supply 1,430 8-C.P. lamps. The total length of feeder main is a little more than 3½ miles, and will carry current for the supply of 17,000 8-C.P. lamps; the total length of low tension main is 3½ miles, and is sufficient to supply 10,000 8-C.P. lamps.

For street lighting 22 Siemens 2,000 C.P. arc lamps have been erected on iron posts in the Finchley Road. Each lamp-post consists of a substantial cast-iron base, surmounted by a wrought-iron stem and an arched bracket. The arc lamps are connected up in series, and are supplied with current through a Siemens cable protected with iron armour and insulated with vulcanised rubber.

The building contractors are Messrs. Yerbury & Sons; the general plant contractors are Messrs. Siemens Bros.; Messrs. Willans & Robinson supplying the engines, Messrs. Belliss & Co. the boilers and pipes, and Messrs. Lucas & Aird building the sub-stations.

Prospects of the Undertaking.

Applications have been received for about 3,000 8-C.P. lamps, there being probably 1,400 connected. The price per unit is to be 6d., though a lower price per unit during the day is being considered. It will be interesting to note the progress of the station, for the neighbourhood is purely a residential one. The houses for the most part are, however, of considerable size, inhabited, presumably, by wealthy persons. We should expect that the consumers will be numerous, and with the ability to cover the whole of the very wide area, there should be little fear of the undertaking proving to be a most prosperous one.

BUSINESS NOTICES, &c.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation the 1895 edition of this directory, which embraces all connected with the electrical trades throughout the Universe. It is indispensable to all having business transactions in the electrical world. Names and addresses for insertion, corrections, and orders for advertisements should be promptly forwarded.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee of the Aberdeen Town Council held on Wednesday, 26th ult., the city electrical engineer (Mr. Ruthven-Murray), reported that in consequence of the large and increasing demand for electric energy, an extension of plant would be immediately required. He stated that there were now 80 consumers having, in all, 7,000 lamps connected to the mains. It will be remembered that the station was opened on February 28th last, and the fact that an extension is required in less than seven months shows with what popularity the light has been received. The progress of electric lighting in Aberdeen has been exceptionally rapid and successful. The supply was commenced at a most disadvantageous time, as the city is so far north that in summer there is practically no night. A large proportion of the load is shop lighting, but it also includes three hotels, a few private houses, Robert Gordon's College, and the School of Art. The committee resolved that Prof. Kennedy should be requested to report as to what additional plant he would recommend should be provided.

Aberystwyth.—On Tuesday evening the Mayor and Corporation of Aberystwyth inaugurated the installation of the electric lighting of the Marine Front and main portion of the town. The Marine Esplanade is lighted by arc lights of 2,000 candle-power, placed 45 yards apart, and similar lamps are placed in the main thoroughfares.

Africa. — The first section of the trans-Continental telegraph line is stated to be open as far as Blantyre.

The South African correspondent of the *Financial News* states that the Meyer and Charlton Company is about to follow the May Consolidated Company's example in adopting the Siemens-Halske electrolytical process of treating tailings.

Bacup.—The Town Council have refused to consent to the application of Mr. Alex. Wright, who desires to erect two overhead electric lighting wires across Burnley Road from the Liberal Club to his new offices.

Belfast.—A report was read at the last meeting of the Electric Lighting Committee from Prof. A. B. W. Kennedy, on the testing of the gas engines at Kilmarnock. Work in connection with the central station is progressing.

An assistant resident engineer is to be appointed for the central station. Applications for the post are shortly to be invited by the Electric Lighting Committee.

Bermondsey.—Tickner & Partington, of Harrow Road, N.W., have recently re-installed the electric light at the offices and mills of Spratt's Patent, Limited, Bermondsey, to the extent of 170 16-C.P. lamps, the current being generated by a large dynamo driven by a gas engine. The dynamo also supplies current to several magnetic separator machines, and to a motor fan in the offices, the whole now having been working satisfactorily for some time past.

Bristol.—The lanterns outside Messrs. Verrier's shops and warehouse in Wine Street have each been fitted with a 500 C.P. arc lamp, and the whole of them, 12 in number, were lit for the first time last Saturday evening. Brockie-Pell lamps are used.

Cardiff.—A deputation, consisting of several members of the electric lighting committee, are coming to London to select fittings for the Town Hall electric lighting, for which, as we stated last week, Messrs. Fergusson & Co. have the contract.

Cheltenham.—The erection of the electric lighting station is making satisfactory progress, and last Wednesday a memorial stone was to be laid by the Mayoress.

Corsham.—Under the auspices of the local Technical Instruction Committee, Mr. William Wilson, M.A., of Bristol, delivered a lecture in the Town Hall some days ago.

Dewsbury.—A 75 horse-power engine has been erected at the new electric lighting station by Messrs. Willans & Robinson, and has been coupled to a dynamo of Messrs. Crompton & Co.'s. Two larger engines, of 150 horse-power each, are to arrive shortly. It is expected that within a very few weeks the installation will be complete.

Derry.—At Tuesday's meeting of the Lighting Committee of the Corporation, the resident engineer (Mr. Christie) reported, says the *Northern Whig*, that since September 6th there had been 12 more breaks in the cable. Some of these had left 44 lamps in darkness on particular nights, and some of them a smaller number of lamps. In two or three instances the breaks had occurred during testing, but in the majority they had occurred during ordinary running. Councillor Thompson said in connection with the testing they would be astonished at the revelation he was about to make. Their engineer, Mr. Blake, drew up a specification which was submitted to Dr. John Hopkinson, of London, for his approval. On Dr. Hopkinson approving of the specification, tenders were invited. Messrs. Siemens Brothers' tender for the cables was accepted. A few days ago he asked regarding the tests that were to be given to the cables according to the specifications, and he was told they had all been given. On making enquiry he got the original specification sealed by Messrs. Siemens Brothers, and he was astonished to find that the clause relating to the official tests—the clause that was in the document submitted to Dr. Hopkinson, and approved by him—had been struck out. In the document with which Messrs. Siemens accompanied the specification they said the tests as mentioned were impracticable. So far as he knew, it was not known by the Corporation when they accepted Messrs. Siemens's tender that it was *minus* the clause relating to the test. Alderman Bell said this was quite a revelation. The Mayor suggested the committee should adjourn, and request the attendance of Mr. Blake. Councillor Turner said when he moved that the plant should be taken over from Messrs. Siemens, he did so on the certificate that the work had been done to Mr. Blake's entire satisfaction. He knew nothing of any modification of the specification. A long discussion ensued as to what was best to be done in the matter, and eventually a motion was carried that, considering the gravity of the matter referred to, the meeting adjourn, and that Mr. Blake be requested to attend the adjourned meeting. Mr. Christie, in his report, added that one of Messrs. Siemens's head electricians, who had been sent over to look into the cause of the repeated flaws in the cables, was in the station when one of the breaks took place. He had now returned to London to report to Messrs. Siemens.

Dover.—Some experiments are being made with incandescent gas lighting. The Town Council received notice from Mr. Lawson, engineer of the Dover Electricity Supply Company, of the intention of the company to lay their mains in Elizabeth Street and Clarence Place, and to build a transformer chamber there. Permission was given.

Edinburgh.—A committee are to report *re* the lighting of certain streets by electricity. Some of the councillors want the incandescent gas light adopted instead.

Folkestone.—A committee has now been appointed to go thoroughly into the question of the proposed electric light scheme, and Mr. Medhurst is to be asked to assist in the working out of details and preparing specifications and plans. Later Mr. Medhurst will probably prepare the necessary documents connected with the application for a provisional order. The town is to be canvassed to ascertain the probable consumption. At last week's meeting of the Corporation there was a rather warm time and a great deal of cross-fencing between councillors, but the proposal referred to above was in the end carried by seven votes to three.

Galston.—A lecture on the "Applications of Electricity" was delivered at the Brown Institute last week.

Hawarden.—The proprietors of the Aston Hall Brick and Tile Works have arranged for the lighting of the entire works by electricity.

Hertford.—The Corporation last week decided to make application at once to the Local Government Board for a loan of £6,000 for carrying out the electric lighting scheme; £700 for the land, and £5,300 for the necessary plant, &c.

Hull.—The staff at the electric light station is to be increased this winter, this course being made necessary by the large demand for electric light.

It still wants nearly a fortnight to the date stipulated for sending in of tenders for the purchase of the Hull Street Tramways. The opinion is strongly expressed, writes a correspondent of a provincial paper, that the Corporation should purchase the two tram services in the town, should reconstruct them with a double line of rails, and then either let them or work them themselves; the latter course having apparently most advocates. The suggested introduction of electricity finds much favour, as it would get rid of the nuisance caused by the use of horses, and also ensure greater regularity. The remarks made by Dr. Holder at the last meeting of the Electric Lighting Committee lend force to this view. Although disavowing any authority for his remarks, he said that it was probable that the trams might be purchased by the Corporation, and that it might be determined to work them by electricity. To meet such an emergency, he spoke of the importance of a new system of storage, and on his recommendation it was resolved to authorise the engineer to make an experiment.

Isle of Man.—On Monday, last week, there was a gathering at the Douglas Bay Hotel of local gentlemen and others connected with the Douglas and Laxey Electric Tramway. A dinner was held in celebration of the completion of the line.

Keighley.—At the last meeting of the Council a proposal was brought forward in favour of making application to the Board of Trade for a provisional order to supply electric light. The Gas Committee, however, who had brought forward the proposal, considered it rather premature, as only a few people had signified their desire to have the light. The matter was referred back to the committee.

Leeds.—The Yorkshire *Daily Post* contained last week an interesting article regarding the extensions of the electric lighting in that town.

An art department is being added to the Yorkshire College, the rooms being lighted throughout by electricity; arc lamps are hung in the design studio and the life room.

Ledbury.—On 20th ult., at the Worcester County Court, Mr. Oswald Swete, electrical engineer, was summoned for the amount of an hotel bill (£18). Mr. Swete, who was employed by the New British Installation Contractors, endeavoured for them to introduce

the electric light into Ledbury, and it was his hotel bill for his stay in Ledbury that was the cause for action. He stated that his employers were liable for the amount, as all such expenses were paid by them. The judge gave judgment by consent against the company for £17 18s. 5d.

Liverpool.—The Finance Sub-Committee recently received a letter from Councillor Meade-King, suggesting the substitution of the electric light for gas at St. George's Hall and the Municipal Buildings. The sub-committee resolved to reply to Mr. Meade-King that, considering the great improvements continually being made in the electric light, the committee did not think it desirable to enter into any large expenditure on the electric light at the present time.

London.—At the new offices of the *Queen*, *Field*, and *Law Times*, Windsor House, W.C., Messrs. Tickner & Partington have just installed a further 300 16 and 32-C.P. incandescent lamps, and four arc lamps. Arrangements have been made that in the event of the plant failing the supply may be taken through a change-over switch from the City of London Company's mains. The installation now comprises about 1,500 incandescent lamps and 15 arcs.

The *Echo* states that so great has proved the success of the electric lighting in the Royal Academy Exhibition galleries, that it has now been applied to the schools, lecture, and class rooms of Burlington House.

An application was made the other day to Mr. Wyndham Slade on behalf of the Vestry of St. George the Martyr for a summons against the London Electric Supply Corporation, Limited, to recover expenses incurred by the Vestry in filling in and making good certain trenches opened by the company in laying their pipes. A question had arisen between the Vestry and the corporation as to the fairness of some of the charges. Mr. Slade granted the summons.

Luton.—The Town Council last week instructed the Lighting Committee to report upon the question of lighting the borough by electricity.

Macclesfield.—The drapery premises of Mr. Robinson Brown, Mill Street, have been lighted with electricity.

Maidstone.—We hear that the idea of extending the electric light from the Technical School to the Museum has been abandoned. The initial cost of the dynamos and installation was put at over £900.

Middleton, near Leeds.—A system of electric lighting is to be introduced at Middleton, near Leeds, which will probably be in many respects unique in the country. Middleton is the property of the Middleton Estate and Colliery Company, Limited, and upon the estate are two mansions, a colliery, a village having a population of 1,200, and provided with a church, schools, chapel, and workshops necessary for the maintenance of the colliery. The owners of the estate recently requested Mr. T. H. Churton, electrical engineer, of Leeds, to prepare a scheme for lighting the greater part of the estate, including the mansions, church, schools, chapel, works, &c., by electricity to be generated at the colliery, and the necessary work is now being carried out by Mr. Churton. A constant supply of electrical energy is to be developed at the colliery, the power being derived from a steam engine, which is also used for ventilating the mine, and which has two cylinders of 24 inches diameter and a stroke of 6 feet. The electrical plant will include an alternating current dynamo capable of developing 20,000 watts when driven at a speed of 850 revolutions per minute, and is being constructed by Messrs. John Fowler & Co., Limited. A current of 20 ampères, at a pressure of 1,000 volts, will be available, and will be transmitted from the source of power to the several points at which it is to be utilised by means of an underground concentric cable designed by Mr. Churton, and specially made for the purpose by Messrs. W. T. Glover & Co. The length of this cable will be about 2,300 yards. Suitable transformers will be erected at each point where the cable is "tapped," the pressure of the current in the buildings to be lighted being thereby reduced to 100 volts. In addition to the lighting above-mentioned, a number of arc and incandescent lamps will be erected and installed at the colliery to light the yard, buildings, and offices. It is expected that the work will be completed about the middle of November.

Monmouth.—At the meeting of the Corporation on Monday, the official seal was affixed to agreements with Messrs. Bramwell & Harris, and Mr. Charles N. Lailey, C.E., for preparing plans and specifications, and superintending the work of a combined scheme of drainage and electric lighting in the borough at an estimated cost of £17,600—£12,000 for drainage, and £5,600 for electric light. The Corporation are to pay the engineers 5 per cent. on the total outlay and out of pocket expenses.

Morley.—The Town Council have decided to order an engine and dynamo from Messrs. Fowler & Co., of Leeds, for the purpose of lighting the Town Hall by electricity. It will be remembered that recently the scheme of Mr. Robert Hammond was adopted for the lighting of the town.

Newcastle.—At the re-opening of the library of the Newcastle Literary and Philosophical Institution, Mr. James Swinburne lectured on "Some Modern Applications of Electricity." Lord Armstrong was in the chair.

Nottingham.—Five boys have been fined for damaging telegraph wires and insulators by wantonly throwing stones thereat.

Paddington.—St. Saviour's, Paddington, is now lit by electricity, a single parishioner having borne the cost. The seven sanctuary lamps are given by the vicar and Mr. Tweddell.

Portsmouth.—The Overseers have assessed the electric lighting works at £3,500, which means that some £1,200 a year will have to be paid out in rates. If this rateage is persisted in, the prospective profit of £257 on 12 months' working will be replaced by an apparent loss of £1,000, which the Council will have to provide. The committee hope to induce the overseers to make some alteration.

Spain.—A despatch from Madrid reports that two kinds of powerful search lights, one movable and the other fixed, are being made in Paris, for Melilla, for use in night attacks.

Wandsworth.—The Board of Works have decided to disapprove of the proposed works and plans of the County of London Electric Lighting Company, Limited, and to object to the construction of the transformer chambers in the public way, and to the unnecessary number of crossings proposed.

St. Helen's.—Mr. Robert Hammond has paid a visit to St. Helen's, and discussed with the committee the local circumstances connected with the proposed electric light supply.

Sunderland.—The Electric Lighting Committee last week considered the proposal to light the Museum and library with electricity. The question was adjourned for further information regarding the probable cost, &c.

Worcester.—The public supply by the Corporation will commence on the 11th inst. The demand for current is exceptionally good, the equivalent of over 4,000 8-C.P. lamps being connected, excluding the waterworks pumping machinery and the street lighting. The Exhibition, which also opens on the 11th inst., promises to be a great success, twelve firms taking part in it. Among the attractions will be electric cooking, telephones connected to London theatres and the Edison phonograph. A portion of the civic banquet on the opening day will be cooked by electricity.

Bankruptcy.—At a sitting of the London Bankruptcy Court held last Tuesday, before Mr. Registrar Hope, Arthur Shippey, whose bankruptcy we have already referred to, attended for his public examination. At the conclusion, he said that he hoped the realisation of his present assets would yield a better result than his two previous failures, and he promised to do all in his power to assist the trustee to effect a favourable realisation. The examination was ordered to be concluded.

Change of Address.—Messrs. Gilbert & Co. have now entirely removed from Hanway Street to their new and more extensive works situated at 142A, Oxford Street, W., where they have increased facilities for manufacturing their specialities. Their office address will be at Kensington, as before.

Dynamo-Magnet Steel Castings.—Messrs. Edgar Allen and Co., Limited, of Tinsley, Sheffield, are the sole makers of the patent imperial dynamo-magnet steel. Some castings manufactured by them have been subjected to vigorous tests by Prof. J. A. Ewing, F.R.S., Prof. Andrew Jamieson, Mr. Gisbert Kapp, M.I.C.E., and the Electrical Standardising Institution of London. Notwithstanding the dissimilar method of testing adopted by these gentlemen, they appear to be unanimous in their praise of the steel, which they consider most suited for use in the field-magnets of dynamos. A number of permeability curves accompany the reports, and the curves of the several gentlemen compare very favourably. Mr. Gisbert Kapp, who has been longer engaged upon the tests than have the other gentlemen, considers they "are decidedly superior to wrought-iron forgings," and the material is "better than any magnet steel" he has ever tested previously. Prof. Ewing, in a report dated July, 1894, also states that he has not hitherto met with any material "so well suited for use in the field magnets of dynamos." These reports and curves are bound together in pamphlet form, and a separate circular gives examples of mechanical tests of the castings.

Fire.—We regret to learn that the works of J. D. F. Andrews & Co., at 15, Marsham Street, have been completely burnt down. This, however, will make no difference to the execution of contracts or carrying on the works as usual, as temporary arrangements have been made with Messrs. Sharp and Kent to use their Lowndes Street Works. Messrs. Andrews will have temporary offices at 34, Victoria Street.

"Sell's Telegraphic Directory."—We have received a copy of the third supplemental issue to the 1894 volume of "Sell's Directory of Telegraphic Addresses."

Telephones at the Law Courts.—By permission of Lord Chief Justice Russell, an experiment in telephony is being made at the Royal Courts of Justice in the Strand. The experiment is being made in the Court of the Lord Chief Justice, where advantage is being taken of the recess to fit a receiver clasp to the bench, a second at the desk of the clerk of Court, and a third at the counsels' bench. The idea, says the London correspondent of the *Edinburgh Evening News*, is that solicitors and others who are interested in any case may, by having their telephones connected with the Court of the Lord Chief Justice, listen in their own offices or residences to the legal arguments which are advanced on one side or the other, as well as the decision of the judge. Of course, apparatus could be fixed by private means, or on a special circuit or circuits, but under existing telephonic arrangements we fail to see the feasibility or desirability of such a course. It is difficult, sometimes impossible, to hear judgment delivered in Court; through the telephone it would be hopeless unless with special apparatus and special judges.

CONTRACTS OPEN AND CLOSED.

OPEN.

London, W.C.—October 26th. Mr. John Annan, manager for Samuel Wheeler, Esq., "Official Receiver in Companies' Liquidation," acting as liquidator of J. W. Hobbs & Co., Limited, is prepared to receive tenders for the supply and erection on foundations, &c., provided by contractor in the hotel in course of completion on the Salisbury Estate, Victoria Embankment, of the following plant: (Section A) boiler house plant—boilers and fittings, feed heaters, electric feed pump, injector, water tank, steam, exhaust, feed, blow-off, and sundry pipes and valves, &c.; (B) engine house plant—oil tank, steam dynamos, oil filter, workshop fittings, ventilating fan, &c.; (C) switchboard, instruments, and meters. Tenderers are at liberty to tender for any section or sections, or for the whole of the sections, but not for part of a section. The ground plan of the buildings, and the specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. Robert Hammond, the consulting engineer, Ormond House, Great Trinity Lane, London, E.C. Tenders to Mr. John Annan, 2, New Court, Carey Street, Lincoln's Inn, London, W.C., and be delivered by October 26th.

Bradford.—October 15th. For supply and erection of feed pumps and steam pipes, for the Corporation. Plans, specifications, &c., can be obtained at the Electrical Engineer's Office, Town Hall.

London, W.—October 8th. For the supply of stores for the Great Western Railway Company. Full particulars appeared in last week's issue

Manchester.—October 8th. For the supply of stores for the Lancashire and Yorkshire Railway. Full particulars were given in our last issue.

St. Pancras.—October 11th. Tenders wanted by the Vestry for works in connection with their new central station at King's Road, Camden Town. Particulars have already appeared in the Review.

Edinburgh.—October 8th. The Burgh Engineer invites tenders for providing and erecting the cast-iron battery standards for the Edinburgh electric lighting station, Torphichen Street. Particulars from the Burgh Engineer, 1, Parliament Square, Edinburgh.

CLOSED.

Camberwell.—The Vestry have accepted the tender of Messrs. Grover & Wood for the construction of a silent telephone cabinet in the Vestry Hall.

West Ham.—The Town Council has accepted the tender of the Brush Electric Lighting Company, at £33 10s., for the additional lights ordered to be placed in the caretaker's rooms at the Canning Town library. The following tenders were received for providing telephonic communication between the Town Hall and the new public hall:—Consolidated Telephone Construction and Maintenance Company, £26; Postmaster-General, £23 10s.; and the National Telephone Company. The amount of the last tender is not stated. The tender of the Postmaster-General was accepted.

Kendal.—For supplying and fixing telephonic communication between the gas company's offices, Parkside Road, and the borough treasurer's office, 69, Highgate, for the Urban Sanitary Authority.

J. Tanner, 54, Stramongate, Kendal ...	...	£21	5 0
W. Wilson, Entry Lane, Kendal... ...	...	21	15 0

Mr. Tanner's tender was accepted.

Portsmouth.—The Electric Lighting Committee received the following tenders for electric light casing at a schedule of prices: Mr. E. Lane, Portsea; Mr. J. R. Penning, Southsea; and Messrs. Bailey & Son, Portsmouth. Mr. Penning's tender was accepted.

Stafford.—The following tenders have been accepted on Dr. Hopkinson's recommendation:—Siemens Bros. & Co., underground cables; W. G. Bagnall, Limited, cast-iron mains (£75).

Worcester.—The contract for the wiring of St. George's Church has been obtained by Messrs. Verity & Sons, the specification having been prepared by Mr. F. R. Davenport.

Newcastle.—The North-Eastern Railway Company have decided to light Tyne Dock by electricity, the order being placed with Messrs. Crompton & Co., through their local representatives, the Corlett Electrical Engineering Company, Limited. The installation will include two boilers, three engines, three dynamos, and 60 arc lamps (Crompton-Pochin), with cable posts and all accessories.

Cheltenham.—Twenty-one tenders were received for the overhead travelling crane, the prices ranging from £78 (quoted by Messrs. J. M. Henderson, of Aberdeen) to £286 (quoted by Messrs. Tangyes). The tender of Messrs. Humpidge & Co., Stroud, £82, was accepted. For castings for street boxes, 22 tenders were sent in, and the lowest, that of Messrs. Thos. Spittle & Co., at £6 10s. per ton, was accepted. Correspondence with the Brush Company on the subject of their contract for transformers was read and approved. The electrical engineer was authorised to procure the testing apparatus required at the central station, at a cost of about £300, as provided for in the estimate. Wednesday, October 3rd, was fixed as the date for the laying of the building stone at the electric light station, the Mayoress being asked to perform the ceremony.

BOOKS RECEIVED.

Electric Lighting Plants: Their Cost and Operation. By W. J. Buckley. Published by Wm. Johnston Printing Company, Chicago.

Electric Transmission of Energy. By Gisbert Kapp. Fourth edition. Price 10s. 6d. Published by Messrs. Whittaker & Co., London.

Telephone Handbook. By Herbert Laws Webb. Published by th *Electrician* Publishing Company, Chicago, Ill.

CITY NOTES.

Brush Electrical Engineering Company.

The annual general meeting of the shareholders of the Brush Electrical Engineering Company was held at the Cannon Street Hotel on Monday afternoon, Mr. J. B. Braithwaite, jun. (Chairman), presiding.

In moving the adoption of the report, the Chairman said the past year with the company had been one of continuous employment in their factory, and one of great commercial prosperity, considering the very keen competition which they had had to meet in their business during the period under review. If they turned to the balance-sheet, they would see that there had been no change in the capital issued during the year. Shares issued and debenture stock remained the same. The was an increase in the creditors, which was counterbalanced by a corresponding increase in the debtors on the other side. The increase was due to the increased business done, which was about 50 per cent. The loan from bankers on security stood at £25,000. They might ask why they did not issue further capital instead of borrowing from the bankers, but the answer was that they did not require any additional working capital. The reasons for getting a temporary advance from the bankers were reasons of a temporary character. One was the increased overturn of business, and one the large amount of money they had locked up in retention funds on the municipal contracts they had accepted. In undertaking those municipal contracts, it was usual for a provision to be inserted that a considerable amount of the total sum of the contract should be retained in the hands of the municipality until the plant had been set to work, and had run for a certain period to the satisfaction of the borough engineer. The same retention clause existed in regard to the large contracts with the City of London Electric Lighting Company. They were owed £158,000, and something like £50,000 or £60,000 was represented by that retention money, which would come in, and a good deal of it very shortly, and as soon as it came in there would be no necessity to have an advance from the bankers. To issue capital, therefore, would only burden the company with additional charges. Then, on the credit side of the balance-sheet, they had £43,000 worth of shares and debentures in other companies. It was probable that in the present year at least half of that amount would be realised and turned into cash, which would enable them to repay their bankers' loan. They considered it better to temporarily rather than permanently increase the charges, as would be done by the issue of debentures, or preference or ordinary stock, and he hoped they would approve of the course adopted. The next item—provision for depreciation on property, patents, and goodwill accounts, £5,385 2s. 1d.—required a word of explanation. On the credit side of the balance-sheet there was an item of £9,000 under the heading of "Property, patents, and goodwill." They would remember that some two or three years in succession they wrote a lump sum of £3,000 off that item. That had appeared as a sort of inner reserve fund to meet any depreciation which might arise. He did not think that inner reserve fund should appear in the books unknown to the shareholders, and personally he had rather the balance-sheet should show the position to the shareholders to the fullest possible extent, and he suggested to the auditor to bring back that £9,000 on one side of the balance-sheet, and show it as a reserve against depreciation on the other. They had brought that £9,000 back, and in the past year had deducted from it the balance of the cost of the Manchester and Cardiff stations, which were closed during the year, viz., £3,614 17s. 11d., leaving them at the present moment with an available reserve for depreciation of £5,385 2s. 1d., in addition to their reserve, which now amounted to a little over £1,000. As to the closing of the Manchester and Cardiff stations, that was the fortune of war. In both places the company was the pioneer of the electric light, and they did it so well that when they applied for provisional orders, the Corporations said: "This is a good thing, and we will do it ourselves and take all the profits." Well, there was nothing for them to do but close their stations, sell their property, and write the thing off, and the difference between the cost of the stations in the books and what they realised was shown in the £3,614 which was written off. Those two matters were now closed up, but he need hardly say that in the present state of the electric light industry there was no necessity for them to pioneer any further work, as municipalities were now convinced that it was to their interest to do the work themselves, and he was happy to say in

many cases they came to the Brush Company as people most capable of supplying them with first class station plant. On the credit side of the balance-sheet there was the property, patents and goodwill increased by the sum of £9,000, which he had explained, and it was also increased by £3,710 in respect of additions to the plant, and the erection of additional shops at Loughborough, where they had the finest electric lighting station in the world, and if any shareholder wished to see it he could write to the manager, who would be pleased to afford every facility. After deducting £5,237 15s. 5d. for property and plant disposed of, and £733 6s. 10d. for amortisation of lease, the item for property, patents and goodwill stood at £287,084 14s. 3d. As to stock in hand, the goods in process of manufacture, work in progress, and materials in London, Loughborough and other places, stood at £114,681. He was happy to say that none of that plant was being manufactured for stock, but that the men were kept employed on works in execution. Debtors, as he had explained, were £158,691; cash at bankers and in hand £12,965; liquidator's balances £2,110, and the balance of foreign and colonial branches' accounts £76,258 18s. 3d. That gave them a net result, after paying the interim dividend, and charging the interest on the debenture stock for the whole year, of £15,938, out of which they proposed that £12,150 be appropriated to pay the second half of the preference dividend and the dividend on the ordinary shares at the rate of 5 per cent. per annum, and then carry forward £3,788. Probably someone would ask why they did not pay the same dividend as last year, as they had earned it. To pay 7 per cent. would absorb £2,700 more, and they could have done that and still carried £1,000 forward. They had no special reason except that the balance-sheets of two of their competitors—the Electrical Construction Company, and Messrs. Crompton—were of such a character, that it was a good opportunity for them to increase their carry forward. He did not think it sufficient for an industrial company like that to only carry forward £800 or £1,000. Their competitors were hardly able to keep their heads above water—some were not paying a dividend on the ordinary shares, and thus it was a good opportunity for them to increase their carry forward. An industrial company like this could not have too strong a financial position, and it would do them good to carry more forward. He could not prophecy, but he hoped to pay that year 5 per cent. as a regular dividend, and something in the way of a more or less handsome dividend. With regard to the profit and loss account, the gross profit had been £57,157, compared with a gross profit the previous year of £49,405. That was an improvement of £8,000, and taking into account the keen competition of tenders for municipal stations, it was a most satisfactory result, and reflected great credit on their managers and officers and staff generally, all of whom had worked so heartily in the interests of the company. On the other side, the general charges showed an increase of about £2,000, which was their standing charges increased 11 per cent., and their turnover 50 per cent., so they must not grumble at that. The cost of removal to Loughborough was £632, and they proposed to write off £107 for removal from Hammersmith works. They spent more by £1,000 on buildings and plant, which was rather a satisfactory item, as it showed the engineers kept the plant in tip-top order. The net result of the profit and loss account was that there was a profit of £27,280. There was little to call for attention in the balance-sheet of the foreign and colonial branches. The business in Australia had been reduced and hampered owing to the crisis through which that country had passed, but they would be satisfied with the chief manager of the business there in knowing that notwithstanding the financial troubles, the bad debts made did not exceed £50. Now that affairs were reviving, there would doubtless be a revival in their business, and profits would be obtainable from that branch. The Vienna branch had made very satisfactory progress during the year. The work turned out there was exceedingly high. Their engineer there was a very energetic and talented gentleman, and their interests were well served by him in Austria and on the Continent generally. The business there showed a fair return on the capital invested, and he thought it would steadily improve. Proceeding to deal with the trustees' account in connection with the employés bonus scheme under the trust deed, dated January 10th, 1894, the Chairman sketched the history of the scheme, and said that last year 163 of the employés participated, and a sum of £2,488 was distributed. A sum of £1,196 had been invested in 4 per cent. Midland Railway Preference Stock, forming the provident and reserve fund provided by the scheme. As to the general working of the company, he thought it would interest them to know that during the year the stations they had erected for the municipalities of Lancaster and Huddersfield had been opened for work, and they had completed the electric lighting of Arundel Castle for the Duke of Norfolk. They had work in hand for Worcester and Leicester, which would shortly be opened, and also for the Dover Company. With regard to the City of London contracts, they who had attended those meetings several years knew they had reported satisfactory progress year by year. They would remember that when they took the contract the largest size dynamo machine then made was one capable of giving 100 kilowatts, or supplying 3,000 lights. They struck the half-way house by constructing one of 200 kilowatts, supplying nearly 7,500 lights each. They had now constructed one of 400 kilowatts, and they could turn them out capable of supplying 500 kilowatts. Since last year they had erected four more machines of the same size for the City of London to supply 15,000 lights each, and three additional ones were in course of manufacture. In every case their machines had not only come up to the specifications, but had exceeded them, and that really deserved, at that juncture of their history, a word of praise from him as chairman for the technical officers by whom these results had been obtained. Their engineer, Mr. Raworth, was responsible for the designs, and their electrician for the dynamos; and the fact that the machines were constructed from designs four times larger than had ever been done before, and were constructed without alteration, was a high testimonial to the capability of those gentlemen. They had not yet finished with the City of London Co., although they had had very large orders from them, and had large works in execution. They still expected to receive another £100,000 from them, and judging from the success of the company, it did not seem that they would have to wait long before fixing up extra plant to meet the requirements at Bankside. It was no breach of confidence when he told them that the applications for lighting received by the City of London Company last week exceeded 4,000 in number. With regard to the County of London Electric Lighting Company, which they formed last year, they were careful to send specifications to every shareholder, with the wish of giving them an interest in a company which they believed would be not a wit less successful than the City of London: but the shareholders evidently believed more in manufacture than in supplying electric current, as the applications were very small, and he supposed they would go into the market and buy at 50 or 60 per cent. premium later on. He did not think the County of London Company's prospects inferior to those of the City of London Company. They had the district of St. Luke's, Clerkenwell, and the district of Wandsworth; they had a nice electric lighting station at Bournemouth, earning a satisfactory profit, and they had the company at Dover, which would light the pier and harbour, besides provide houses. In addition to that, the County of London Company had secured the outfall at Lake Windermere, and they were applying for a provisional order to extend a 10 miles area, and if they obtained it they would supply the light in that district driven by water power. In other directions the prospects of the company were exceedingly good. They expected something like £1,000,000 orders, so that they felt a benevolent interest in the company's progress. He believed the Brush Company had reason to be satisfied. They had orders to keep them employed till the end of the year, and additional orders were coming in in a satisfactory manner.

Mr. Van Tromp seconded the adoption of the report.

Mr. Boys thought they might have struck a middle course, and given 6 per cent.

The report was then carried.

The Chairman next moved, and Mr. Van Tromp seconded, the declaration of the dividend.

A Shareholder remarked that as he was an old shareholder, and his £10 shares were written down to £5 at the reconstruction, 5 per cent. was not a great deal, and he trusted the board would consider the ordinary shareholders to the greatest extent in their power.

The Chairman replied that it had taken 10 years to get the company back to its position after the way the chairman then played ducks and drakes with the money. The only straightforward thing then to do was to write down the shares, and they had greatly improved their position since then.

The motion was then agreed to.

Messrs. A. H. Saunderson and Col. F. G. Stewart were re-elected directors.

The auditors were re-elected, and a vote of thanks to the board terminated the proceedings.

New Company.—The Milde Telephone and Electric Supply Company has been formed with a capital of £20,000, in 15,000 7 per cent. cumulative preference shares, and 5,000 deferred shares of £1 each, to acquire the patent rights of these telephones in Great Britain and Ireland, and the English colonies, and to establish exchanges, and generally to carry on the business of telephone and electric light contractors.

British Thomson-Houston, Limited.—Mr. Ernst. Thurnaner, general manager in Europe of the General Electric Company, of the United States, and a director of the Compagnie Française pour l'Exploitation des Procédés Thomson-Houston at Paris, and of the Union Elektricitäts Gesellschaft, at Berlin, has joined the board of this company.

The Direct United States Cable Company, Limited.—The board have resolved upon the payment of an interim dividend of 2s. per share, free of income tax, being at the rate of 2 per cent. per annum, for the quarter ending September 30th, 1894, such dividend to be payable on and after the 24th inst.

W. T. Henley's Telegraph Works Company, Limited.—Warrants have been posted for a dividend on the preference shares of this company for the half-year ending June 30th, 1894, at the rate of 7 per cent. per annum.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 30th, 1894, amounted to £881; week ending October 1st, 1893, £798; increase, £83; total receipts for half-year, 1894, £11,118; corresponding period, 1893, £10,479; increase, £639.

The Cuba Submarine Telegraph Company. The estimated traffic receipts for the month of September were £2,700; as compared with £2,880 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of September, 1894, amounted to £1,898, against £1,865 in the corresponding period of last year.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending September 30th, 1894, amounted to £988; corresponding week last year, £649.

The Western and Brazilian Telegraph Company, **Limited. The receipts for the week ending** September 28th, after deducting **17 per cent. of** the gross **receipts payable to the London** Platino-**Brazilian Telegraph** Company **Limited, were** £3,395.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation. September 26th.	Closing Quotation October 3rd.	Business done during week ended October 3rd, 1894. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	30 — 42	39 — 42	39	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	74 — 76	75 — 76	76¾	75¼
2,993,560£	Do. do. Defd.	Stock	...	...	...	6¾ — 7¼	6¾ — 7¼	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½ % §	6½ % §	12¾ — 13¼	12¾ — 13¼	13⅛	12⅞
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	109 —113	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10% ‖ §	... §	1½ — 2½	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —145	135 —145 xd	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	2 % §	⅛ — ¼	⅛ — ¼	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12½ — 13¼	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½ %	4 %	4 %	4¼ — 4⅜	4¼ — 4⅜xd	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9½ — 10	9¼ — 9⅜xd	...	...
30,000£	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½ % §	3½ % §	2⅝ % §	8⅜ — 9¼	8⅜ — 9¼	9 3/16	8⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6¼ % §	6¼ % §	6¼ % §	15⅜ — 16	15⅞ — 16⅛	16 1/16	15¾
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16¾ — 17¼	16¾ — 17¼	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	...	...
1,297,837£	Do. 4 % Mort. Deb.	Stock	...	...	...	118 —121	118 —121	119⅜	...
£50,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅞ — 16⅛	16 — 16¼	16¼	16 1/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	116 —120	116 —120	117	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	...	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	104 —107	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	108 —111%	109 —112%	118½	...
180,227	Globe Telegraph and Trust, Ltd.	10	5⅛ % §	4⅞ % §	4⅝ % §	8⅜ — 9	8⅞ — 9⅛	9⅛	8 1/32
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅝ — 16¼	15⅞ — 16¼	15 19/32	15 19/32
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅗ % §	8⅗ % §	8⅗ % §	20½ — 21½	20½ — 21½	...	...
190,000£	Do. do. do. 5 % Debs.	100	...	...	...	103 —106	103 —106	104	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 48	46 — 48	47½	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	106 —109	107 —110	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼ — ⅜	¼ — ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 1½	1 — 1½	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	4⅞ — 5⅛	4⅞ — 5⅛	5 1/16	5
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 15½	15 — 15½	15½	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½ — 5⅜	5½ — 5⅜	5⅜	...
1,000,000£	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	109 —112	109 —112	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	½ — ⅝	7/16 — 9/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	104 —107	104 —107	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	3 — 5	3 — 5	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	105 —110	106 —111	109	107¼
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	2 — 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	0 %	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	101	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 3	2 — 3	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	101 —106	101 —106	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½ %	2½ %	8⅜ — 9¼	8⅜ — 9¼	9¼	9
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6¾ — 7¼	6¾ — 7¼	7	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	2¾ — 3¼	2¾ — 3¼	3¼	3
171,900£	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	106 —109	106 —109	...	...
214,800£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	106 —109	106 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1⅜ — 1⅝	1⅜ — 1⅝	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10¾ — 11¼	10¾ — 11¼	11	10 1/16
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	9⅜	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	108 —111	110½	110
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	115 —120	115 —120	...	...
166,900£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —103	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½ — 5½	4½ — 5½	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	13 — 14	13 — 14	13⅜	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14½ — 15	14¾ — 15½	15	14⅜
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	130 —132	131 —133	131½	131
50,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	6¾ — 7	6¾ — 7	...	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	9¼ — 10	9¾ — 10¼	10⅛	9⅞
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	5 — 6	5½ — 6½	5⅝	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	7 — 7½	7 — 7½	7⅛	7
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼ — 9	8¼ — 9	8⅜	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	6¼ — 6⅜	6¼ — 6⅜	6⅜	6 1/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Sept. 30th.	Closing Quotation, Oct. 3rd.	Business done during week ended Oct. 3rd, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅝ — 2⅞	2⅝ — 3	3	2 11/16
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅜ — 2⅝	2½ — 2¾	2 11/16	2½
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	109 —112	109 —112	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	36 — 38	36 — 38	37½	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	1¾ — 2¼	2 — 2½	2¼	2⅛
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	94 — 99xd	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	½ — ¾	½ — ¾	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1¾ — 2¼	1½ — 2 xd	1⅞	...
100,000	Elmore's French Patent Cop. Deposg., Ltd, 1 to 66,750 ...	2	*nil*	*nil*	*nil*	9/16 — 5/8	9/16 — 5/8	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅜ — 1⅝	1⅜ — 1⅝	1½	1 5/16
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1⅛ — 1⅜	1⅛ — 1⅜	1 3/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	¼ — 1½	¼ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6⅔ — 7⅓	6⅔ — 7⅓	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd, Ord.	10	5 %	5 %	5 %	7½ — 8½	8 — 8½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23½ — 24½	24 — 25	24½	24 7/16
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7⅞ — 8⅛	7⅞ — 8⅛	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	12¾ — 13	13 — 13⅛	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½%§	... — ...	... — ...	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	42⅛	41⅝
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	102 —105	105—106	105	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2 — 2¼	2 — 2¼	2 3/16	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¼—5⅝.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅝.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
Do. do. £3 10s. paid, 4⅛—4⅜.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

POWER TRANSMISSION IN THE TRANSVAAL.

There are two power transmission schemes in South Africa for the supply of power, says the *South African Mining Journal*, to the Witwatersrand mines. One scheme is to transmit electricity from Brakpan, where there appear to be coal mines, to the extent of 2,000 horse-power at 1½d. per horse-power hour, the capital being £275,000, and the expected dividend, 15 per cent., a nice comfortable little sum, if secured. We are not informed as to the distance. The other is a water scheme, with a proposal to utilise a fall of 80 feet on the Vaal River of 150,000 cubic feet per minute, and transmit a net 11,800 horse-power for sale, 30 miles distant. This scheme involves dams, asks for £700,000 as capital, but only proposes to charge ¾d. per H.P. hour. The fall and supply have a capacity of some 22,500 H.P. Rating turbines at 75 per cent. leaves, with a further reduction of 5 per cent. for friction, 15,781 H.P. delivered to the dynamos, of which 75 per cent. is supposed to reach the mines. The Brakpan, or coal scheme, has allowed a loss of one-third from dynamo terminals to motor. The Vaal scheme is to have a voltage of 20,000, and it is claimed that the water measurement was carefully made at the end of a dry June, 1893.

Water schemes, even in America, have not been singularly economical to power users, probably because of the necessity of steam as an auxiliary or stand-by. In South Africa, where we have been in the habit of supposing fuel and carriage to be very costly, we naturally expect to find a water-power utilisation in its best environment, but from the figures given by Mr. Roberts in his article, we are much surprised to find that during the past year round coal in Johannesburg has averaged 20s., and nuts only 16s., or an average of, say, 18s., which goes to show there must be something wrong in England with coal at present London prices.

The question arises as to the coal consumption at the mines. The Brakpan promoters claim it to be 15 to 18 pounds per H.P. hour. This Mr. Roberts disputes *in toto*, presenting a table for four classes of mining plant wherein the coal varies from 4·06 to 13·08 lbs. per H.P. hour, and its cost from ·438d. to 1·412d., and he does not think the average cost exceeds ·858d.: assuming the bulk of plants come under the two middle heads and adding labour, stores and maintenance, &c., he finds 2·340d. But taking the best plants he finds a cost of only 1·305d. per H.P. hour, and at such places the Brakpan scheme could not find much business at its 1½d. rate, but the transmission scheme must look to the old fashioned plants for custom. For the average plant costing 2·34d. and taking 1·807d. as the total cost of the transmitted power, he sees a saving of ·533d. per H.P. hour. New mines, of course, would save more because the above 1·807 includes ·29d. for depreciation of steam plant idle. The margin of saving is thus not great, but for the ¾d. charge of the Vaal scheme there is a better showing to the extent of ·75d. Can the transmission companies supply at the rates given? The cost of 2,000 H.P. per H.P. is given as ·8824d. which includes ·0924d. for coal at the pit mouth and handling at 7s. per ton. There is added ·588 for the dividend, making up a total of 1·4704d. per H.P. hour. Now, 7s. per ton is a low figure, and the price must be 1½d. to meet expenses and profit. Similarly for the Vaal project of 11,800 H.P. the cost is ·2544, and the dividend, which is calculated on £800,000 instead of on the proposed £700,000, is ·2904, making a total of ·5448d. per H.P. hour. If only 6,000 H.P. be sold, then the cost will be ·8254, including profit which would admit of less than 1d. charge. So far as such schemes can be analysed, that of the Vaal certainly makes much the better showing, but it may be argued that though the coal scheme shows a narrower margin it has also a less speculative motive power, dams, and reservoirs, often running deeper into capital than even the most liberal of estimates, but £100,000 has been added by Mr. Roberts for contingencies in making up his estimates for the Vaal scheme. The Brakpan scheme is proposing a high charge per horse-power hour if coal can be had at the mines

at the prices given for Johannesburg. One thing appears certain, even from the figures given by Mr. Roberts, who is favourable to both schemes, that neither of them offers power at as low a rate as the first class and fair average mine plants already obtain it, and it still appears that to secure much custom there will require to be a far larger difference between coal cost as delivered and at the pit than appears to be the case on the Rand. If the water scheme can be carried out for the money, however, it may do well, especially if something more moderate as a dividend is looked for.

Where a large mine has outlying isolated engines, not perhaps so economical as its large engines, it appears that at the prices given it might transmit its own electrical power to such outlying parts of its property for as little as it could purchase from the outside companies. So far, however, the published figures are insufficient upon which to arrive at any very definite conclusions.

THE "TAUSSIG" PROCESS OF ELECTRICAL SMELTING.

Amongst the large number of electrical smelting processes which have been received under the aegis of the Patent Office, but few have, so far, been exploited on a commercial scale. Capitalists, for the most part, have not had the courage to give active support to proposals which, in many cases, have appeared to be almost revolutionary. Moreover, there is no doubt that any success attained in a new department of electrical engineering is certain to be succeeded by a mushroom growth of palpable and inefficient imitations: and this is true in every other branch of industry.

It has been complained, we think a little unjustly, that the application of electricity to smelting and other metallurgical operations is dependent upon the use of costly and complicated plant. Simplicity is, of course, a *desideratum*, and it is towards this that all processes, whatever their object, tend. Already several of the new electrical methods of dealing with ores and metals may be strictly designated as simple in design and easy of operation. Amongst these may be placed the process invented by E. Taussig, of Bahrenfeld, Germany, which has been devised for smelting and casting metals by electrical heat under the influence of rarefied air. The ores or metals are fused in a closed furnace, the hearth of which is connected with moulds, into which the fused metal flows; the air in the moulds and furnace being rarefied, as far as practicable, through exhaustion by means of air pumps.

In reporting upon Taussig's process a few weeks ago, the United States Consul-General described the plant as consisting of a long air-tight smelting channel or chamber, the hearth of which inclines to a central orifice, through which the fused metal passes into the moulds. This chamber is filled with the material to be smelted, and heat is generated by passing an adequate current of electricity through the mass without employing carbon electrodes. The furnace is lined with fire-bricks of such non-conducting properties as to insulate perfectly the contents, so that the heat is developed where it is required, very little, if any, loss of current taking place.

It appears that a degree of heat sufficient to melt pig-iron in 15 minutes can be generated and maintained without unduly heating the other parts of the circuit; and this is equally true of the smelting of easily fusible metals like lead and zinc, or of Siemens-Martin steel, which is known to be one of the most refractory of all the generally used metals.

The entire absence of coke, coal, or carbon electrodes, secures to the fused metal nearly absolute purity, and the continued exhaustion of the air and gases generated during smelting is stated to increase the fluidity of the molten material, to prevent oxidation and blistering, and to bring about a dense smooth quality which is associated with the highest mechanical properties of which cast-iron is capable.

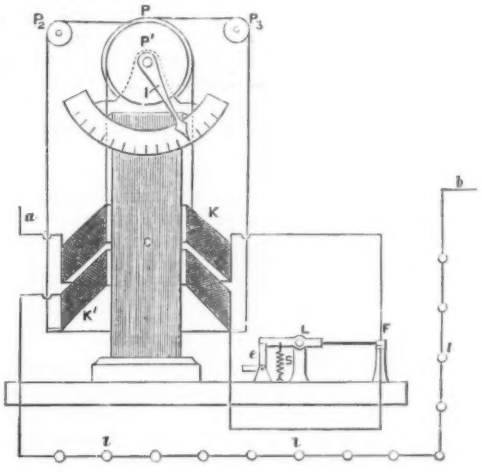
For smelting raw ores, the most obvious advantage claimed for the Taussig process is that it can be worked wholly by water power and without fuel in mountainous or remote regions, which, while producing metalliferous ores and having abundant water, possess no coal and possibly little other fuel. Other advantages, however, have been pointed out, besides those which have been already referred to *en passant*, and by no means the least of them concern the quality of the finished metal. A short time ago some tests were made by the Royal School of Mines, at Berlin, of pig-iron produced by direct smelting from Swedish ore. The tables of results are too abstruse and complicated to be of general interest, but the net results may be summarised in the statement that the tractile strength of a cylindrical rod 10 mm. in diameter was 3,410 lbs., and the resistance to compression of a rod 301 mm. long and 30 mm. in diameter was 127,270 lbs.

NEW CONSTANT CURRENT REGULATORS

Another constant current alternating regulator is shown in the cut, designed by Prof. Elihu Thomson, who is the original inventor of the constant current regulating transformers now used commonly in connection with rectifying commutators and for arc lamps in series worked from a constant pressure circuit.

This new device is not a transformer, it is a choking coil, or rather two choking coils. These coils, K and K^1, in the figure are wound in contrary directions and coupled in series, so that the magnetising effect of the one is contrary to that of the other. The two coils are hung on cords passing over pulleys, P, P^1, P^2, P^3, and move freely up and down along an iron core, C; laminated pulley, P, is loose on the spindle; pulley P^1 is fixed on the spindle and carries with it an index, I.

An automatic cut-out is seen in the fig., which almost explains itself. The contact at F is closed by trigger, *e*, holding up lever, L, against spring, S.



The action of the regulator is this: when the full number of lamps are in circuit and the current normal, say 5 ampères, the two coils are nearly together, as shown on the index, which may be graduated in ampères. In this position being wound contrary, they neutralise one another and choke the current but little, but suppose some of the lamps short-circuited, the current would increase slightly, for the two coils would be repelled apart and thus lessen the neutralisation and increase the choke, thus keeping the current nearly constant however many lamps may be short-circuited.

This action is very sensitive, the coils are nearly balanced one against the other, but the upper one being heaviest they run together when no current is passing and the index stands at zero.

If, from any cause, the current should rise above a given limit the lower coil comes down upon the trigger, *e*, releases the lever, L, and opens the circuit at F.

Elihu Thomson's previous regulators are transformers, such as are used at Portsmouth and other central stations for constant current regulation. A choking coil device as

now described has some advantages, being simpler than the transformer.

The connections are made by flexible conductors, allowing the free motion of the coils. The automatic cut-out is useful in the case of working incandescent lamps in series.

THE "HALLES" STATION.

If we speak in an electrical journal of the municipal station of the Halles, we can, at least, assure ourselves that we are not broaching a subject with which its readers are unacquainted.

The station is well known. Established in 1889, it was intended by the Municipal Council to serve as a model for subsequent installations. It is also well known how far it is from fulfilling this praiseworthy object. In fact, some have not hesitated to say that if it serves as a model at all, it is as a model of what must be carefully avoided if we would have good results.

Without going so far as this—for, of course, such an assertion is a considerable exaggeration of the actual state of affairs—we must first allow that if there is some foundation for these reproaches, a great deal of the blame must be laid to the account of the defectiveness of the earlier conditions of installation; as regards this defectiveness, we cannot greatly wonder at it when we consider that this installation dates from a time when electricity had hardly emerged from the domain of experiment, and was only just entering upon that of industrial applications.

It must also be added that M. Monmerqué, the engineer of roads and bridges, to whom the service of the station has been entrusted, has spared no pains to modify its bad reputation as far as lay in his power. If he has not altogether succeeded, if the station is still, and probably always will be, far from fulfilling the object of its establishment, at least his efforts have brought about some interesting modifications.

We do not propose to give another description of the Halles station*. We will merely glance at the alterations that have been made in the installation, discussing those points worthy of interest, whether good or bad, and suggesting other improvements that, in our opinion, might be made with advantage.

It should, moreover, be well borne in mind that we are discussing a station managed not by a private company, but by a municipal institution. This is our excuse and justification for a discussion that we should not have entered upon, notwithstanding the fact that subjects of this nature are of general interest, if we had only private enterprise to consider.

General Considerations.

Hygienic Conditions.—However incredible it may seem, it is a fact that the station which is situated in a part of the basement of the slaughter house, and the atmosphere of which is consequently particularly insalubrious, remained for more than two years without any system of ventilation. With a temperature reaching, and even exceeding, 45° C. in summer, the smell of the oil and grease required for the machines, the still more powerful odours from the gutters, established under very bad conditions of evacuation, the whole being accentuated by the smell of bad meat, the condition of the atmosphere of the station can be more easily imagined than described.

It was not, however, until 1892 that measures were taken to protect the health of the staff, which had been seriously affected by these insanitary conditions. Then by means of a ventilator absorbing 10 horse-power, and pipes of perforated sheet-iron, air drawn from the roofs of the Halles was distributed through the engine room and boiler room at the rate of 10 to 12 cubic metres per second.

This was an important step in the right direction, but one which we cannot dismiss without a few observations. Although this new arrangement supplies fresh air in almost sufficient quantities, the solution of the problem is not so satisfactory as regards the temperature. In winter, the cold air introduced from outside, causes draughts which are prejudicial to health, and, therefore, the ventilator remains for the greater part of the time inactive, the renewal of the vitiated atmosphere being suspended. In summer, the air introduced is almost of the same temperature as that inside the station, so that although the air is renewed, it is not appreciably cooled.

We must add that certain measures are being taken that may lessen this last inconvenience.

The engine working the ventilator is also open to some objections. This engine is a Westinghouse engine, turning at a speed of 500 turns per minute. It may be asked whether the addition of another engine to all those already in use in the station was justified in this particular case?

It is now admitted that the greatest efforts should be made to develop the employment of engines in distributions of electrical energy, and perhaps, in this particular case it was logical to open the list of mechanical applications by using one for working the ventilator. It was at any rate a beginning. This has besides been admitted in the installations recently established for completing the ventilation. The first installation of which we have spoken was found to be insufficient, and two more ventilators, of about 5 horse-power each, have been added to the first; this power is supplied by Hillairet machines working under the 230 volts of the continuous current distribution.

But if these ventilators have been well arranged from an economical point of view, the hygienic side of the question leaves much to be desired. In the first place, instead of being distributed through the station by a system of pipes, as in the case of the first ventilator, the air drawn in by these additional ventilators is introduced in a single blast of 5 to 6 cubic metres per second, forming a draught, which is to say the least of it, disagreeable. Then, which is still more objecttionable, the air introduced, instead of being drawn from over the roofs of the Halles, where it would have the chance of being received into the station pure, is collected near the ground, and thus brings with it all the injurious effluvia and microbes with which it becomes contaminated in the neighbourhood of the slaughter-houses. It might not be so very insalubrious in winter, but we could not say the same during the hot weather.

We may also mention the improvements made in the system for carrying away from the station the water in the gutters produced by the condensation from the engines and various other causes. These gutters have been made under such defective conditions that they are below the neighbouring sewer. Until recently the water could only be got rid of by means of a pump, worked by hand, to which a man had to devote the greater part of his time. This very primitive mode of procedure has been replaced by a centrifugal pump, worked by a water turbine, which is put in motion several times a day for a quarter of an hour by connecting it with the water supply.

Lastly, the modifications introduced for hygienic considerations will shortly be completed by the establishment of a bath room, the need of which was pretty keenly felt.

In short, if the condition of the station at present is still far from perfect, at least we can see by this brief description that considerable pains have been taken to improve it. The boiler room in particular, in which, before the introduction of the ventilators, the heat was almost unbearable, is now almost too draughty.

The Lighting of the Station and the Halles.

1. *The Station.*—The lighting of the station, the engine room, the boiler room, offices, &c., is effected now by means of 16-candle incandescence lamps, about 70 in number, absorbing permanently a power of more than 4 kilowatts; or with that expended by the ventilators, about 120 kilowatt hours per day. This is almost a tenth of the total power produced during the summer, certainly an abnormal proportion.

The substitution of over-run lamps for those now in use, which are in service for 1,000 hours and more, has been put off on the ground that the cost of the energy required is not very great and that economy in this direction would not make up for the frequent substitution of lamps; in fact, in reckoning the cost of the energy consumed at the works, the sinking fund which, however, assumes considerable proportions, is not taken into account.

Nevertheless, M. Monmerqué with the laudable object of

* *La Lumière Electrique*, November 23rd, 1889.

reducing this excessive expenditure of energy has lately been considering a project for lighting the station with about 25 arc lamps of from 1·5 to 2 ampères, furnished with holophanous globes.

By this plan, not only would the lighting be superior as regards quantity of light and absence of shadows, but a saving of energy amounting to from 30 to 40 per cent. would be realised. If this mode of lighting were adopted, it would yield us important information as to what might be done in the way of the employment of arc lamps of low intensity, a mode of lighting which *a priori* seems to give great promise. We do not, however, know yet whether this project will be carried out.

2. *The Basements.*—Up to the present, the lighting of the basements of the Halles, which requires 500 or 600 16-candle incandescence lamps, the greater number of them burning continuously, has undergone no modification. It would, however, be interesting to try the over-run lamps, but up to the present this has not been done for the reason mentioned above, viz., that the energy, if we do not take into account the sinking fund, is too cheap to justify the employment of over-run lamps.

In the first place, we cannot exactly see, especially when we take into account the fact that accumulators are used, why the sinking fund is not supported out of the energy expended for the use of the station or for public lighting; if the whole of the lighting, in fact, was of this nature, there would have to be some allowance made for the sinking fund. Then even assuming the price of the energy to be 40 centimes the kilowatt hour, the advantage of over-run lamps is still evident, although certainly it is very slight. But if, on the contrary, we take the sinking fund into account, and base our calculations on the price of 75 centimes, and 1·20 fr. for the purchase of the lamps, this advantage no longer admits of any doubt. It does not require very complicated calculations to see that the substitution of lamps at 2·5 w. lasting 200 hours for 300 lamps at 3·5 w., burning 24 hours per day and lasting 700 hours, would realise a yearly saving of 25,000 francs, or we will say, roughly speaking, 20,000 francs. Even for a municipal station this is a saving worthy of consideration.

3. *Ground Floor.*—There is one modification to be mentioned with regard to the arc lighting of the ground floor. Originally the lamps were grouped four in series, or 240 volts at the extremities of the wires; the result of this mode of grouping was that the different lamps depended too much upon one another, and the working was irregular. It has recently been decided to connect the lamps on each bridge two in series. The results obtained by this alteration, which is now almost completed, have been satisfactory, and the present lighting leaves little to be desired. We will now return to the station. We will discuss in succession:

1. The alterations relating to the boiler room.
2. Those relating to the production and distribution of the continuous current.
3. Those relating to the alternating current.

1. *The Boiler Room.*—Owing to the fact of its being situated in the very centre of the Halles and in the midst of a populous neighbourhood, the station has from the first given occasion for continual complaints about the smoke and coal dust issuing from the chimney; measures have therefore had to be taken to remove as far as possible the causes for complaint.

Comparative experiments had therefore to be made to determine the most favourable mode of working from this point of view. A mixture of close-burning coal and coke was burnt in the Belleville furnaces of four of the generators, and the coal producing more smoke was reserved for the two other generators, which were provided with Hermann & Cohen's smoke-consuming furnaces. These experiments were not altogether successful; as to the mixture of coke and close-burning coal, it was found to be more difficult to manage the fire, and for the last two years this mixture has been replaced by coal containing 10 to 12 per cent of volatile matter without coke. This has been so far successful that complaints from the surrounding neighbourhood are not now of very frequent occurrence. The management of the Hermann & Cohen furnaces was also found to be very difficult; they soon became foul, and when they were cleaned, they allowed the pressure to fall if there was the slightest fault or omission on the part of the stokers. Therefore they were only used at times when the cleaning or repairing of the generators supplied with other furnaces rendered them indispensable, and in 1892 it was decided to exchange them for Belleville furnaces.

Then there is another question. We know to what an extent the consumption of coal under the generators depends upon the skill of the stokers. The natural consequence of this fact is that everywhere every effort is made to make it to the stokers' interest to reduce the consumption as far as possible, either by offering rewards or by allowing them so much per cent. of the saving realised. In almost every case this plan has been found to be successful, and on railways especially it is a regular practice. In this latter case it has even happened, thus affording a most convincing proof of the efficacy of the system, that the saving realised greatly exceeded the expectations of the companies, and that they were obliged to lower considerably the percentage originally fixed. Moreover, the Administrators of Public Works in Paris have admitted these advantages as regards their other works.

This system is not, therefore, one that should be dismissed without a trial, yet this is what was done at the Halles station when a proposition of the kind was made by the Administration.

We may also add that the considerations that dictated this decision do not seem to us very convincing. If the question had been carefully studied, and a few changes made in the present arrangements, this system, which all the known examples lead us to consider an improvement, would probably have been adopted.

In short it seems—the production of 1 kilowatt-hour requiring at present from 4 to 4·5 kilogrammes of coal—that it would be a simple thing to save, perhaps, one or two tons out of a daily consumption of 10 to 15 tons, and thus to realise an annual saving of 10 to 20,000 francs. In any case there would be no risk in trying the experiment.

Perhaps, to a certain extent, the above consideration belongs to the category of questions relating to the amelioration of the moral and pecuniary position of the staff, and their difficulties in obtaining pensions. It may seem strange, but the workmen employed in the station are not placed in this respect on an equal footing with other men employed by the City of Paris, including the road-sweepers, although they are certainly not lower in the social scale.

A petition was presented more than a year ago to the Administration to put a stop to this inequality, which could not be justified on any grounds; but, up to the present, no solution of the question seems likely to be brought forward.

And yet a certain amount of importance is justly attached to this question of pensions, even setting aside all moral considerations.

Without a pension the workmen employed at the station can never hope to retire; on the mere caprice of a superior, they may suddenly find themselves without work; this must have been the case more than once, seeing that since the inauguration of the station, at the end of 1889, the staff has been renewed nearly four times; when ill, and their illnesses are generally contracted through their work, they are only entitled to half their salary.

This state of affairs is worthy of the consideration that the Municipal Council has always shown for the welfare of the men employed in the work of the city, and now that the occasion presents itself, we take the liberty respectfully to call attention to it.

The Continuous Current.

Two important alterations have been made with regard to the production of the continuous current: 1st. The plant for its production has been completed by the addition of a powerful battery of accumulators; 2nd. The Lecouteux and Garnier engines, working the Ferranti alternators, now combine to a certain extent to produce the continuous current.

We will discuss these two alterations in turn, beginning however with the second, which will facilitate the comprehension of certain arrangements adopted with regard to the battery.

The Utilisation of the Lecouteux & Garnier Engines for the Production of the Continuous Current.—Owing to various circumstances, and particularly to the contract with the shops of the Belle Jardinière, the station is compelled to keep the high tension system working uninterruptedly during the day.

The daily consumption is almost nil, and consists, with the exception of that required for some lamps placed in the basements of the Belle Jardinière, of the energy expended in heating the transformers.

The result is that during the day an alternator and a 150 H.P. engine are working incessantly to produce about 15 H.P. This is a deplorable efficiency, and all the more so as the energy expended is turned to scarcely any account.

In order to improve this state of affairs, the following arrangement has been resorted to, the first idea of which, if we are not mistaken, must be attributed to M. Lecomte-Denis, mining engineer, who has been connected with the station for some time.

The axle of the fly-wheel of the Lecouteux & Garnier engines has been extended, and by means of a Raffard flexible coupling it works two pulleys of smaller diameter. These, by means of belts, drive two multipolar Desrozier dynamos of 150 volts and 250 ampères, intended to charge the battery of accumulators recently installed. This being explained, it is easy to understand the object of this arrangement: the output of the Desrozier dynamo is regulated either by means of their excitation or by varying the number of troughs on the circuit, so that, as far as possible, the exact supplement of the power available at each moment on the steam engine should be absorbed. The engine thus works constantly at full load and, consequently, under much better conditions as regards efficiency.

When the load on the high tension system becomes sufficient to absorb alone the whole of the power of the engine, the output of the Desrozier machines is reduced to zero, and it would be useless and even wasteful then to continue to drive the supplementary pulleys and Desrozier machines. The load is, therefore, transferred to another machine, started for the purpose, and the first one is then stopped and the flexible coupling removed in a few minutes; it is then again put on service and again bears the load.

This arrangement was only able to be carried out with two out of the three Lecouteux and Garnier engines; it could not be effected with the third for want of room, but this did not matter, as the corresponding alternator was generally reserved for use when working with the maximum load.

We said, just now, that the available power of the engine was utilised by means of the Desrozier machines, for charging the accumulators. This is not altogether the case, however, and it is better that it should not be, for otherwise, the gain of efficiency in the steam engine being compensated by the factor pertaining to the efficiency of the accumulators, either 60 or 65, the improvement would be almost imaginary.

In reality, the accumulators serve, for the most part, as regulators for the energy supplied by the Desrozier machines, which is utilised directly on the low tension system. In consequence of the lighting of the station and the basements, the daily consumption on this system is not less than 40 kilowatts.

Under these conditions the alteration that I have described has brought about a genuine improvement. The Weyher and Richemond engines working the Edison dynamos of the low tension system are stopped nearly all the day, and are only started when the full service is required. During the day, therefore, the machines actually working are reduced to one single group out of the six contained in the station.

In short, the opinion that we must form with regard to the régime of working seems to be the following:—

This régime is very good as regards the consumption of coal.

It is less satisfactory as regards the staff, although their importance must be taken into account, since the working of the machines during the day is not wholly suppressed.

Lastly, as regards the good utilisation of the stock, *i.e.*, the diminution of the comparative importance of the expenses of the sinking fund, the state of affairs is not altogether ideal, since its interest lies chiefly in the fact that the daily utilisation of the plant is very insignificant. But this need not surprise us, for it is unfortunately the general rule at other places besides the Halles station.

The new state of affairs may altogether then be considered as a decided step in the right direction. When speaking of the alternating current, we shall have occasion to mention another project, more original from certain points of view, and destined to increase yet more the mutual dependence of the two systems.—G. Claude (*La Lumière Electrique*).

PISTON VALVES FOR STEAM ENGINES.

By W. H. BOOTH.

Some little time ago, at a meeting of the Newcastle and District Association of Engineers, Mr. J. W. Smith, of Derby, read a paper on "Piston Valves." To the present writer, whose earliest practical experience with the valves of steam engines was with those of the piston type, the subject seems a trifle hackneyed; nevertheless, there is comparatively little general knowledge of the appliance. It is certain that piston valves were made by Messrs. Mather & Platt as far back as 1873, and regularly put by them into large steam engines, and since the year 1860, or earlier, another north country firm of engineers, Messrs. Petrie & Co., of Rochdale, have made no other valve for their large engines. The valves of this latter firm, however, differ from all other piston valves in combining in one valve the ordinary functions of an exhaust and steam distribution valve with an automatic expansion valve, this latter function being attained by the addition of several equally spaced projecting wings on the steam edge of the piston which ordinarily come between the steam ports in the seating or cylindrical shell in which the valve works, but, upon a rotation of the valve spindle through a small angle the steam ports are covered by the wings, and this partial rotation can be effected by a quick-acting cam motion, or, as in the Corliss valve gear, by a detent and dash-pot gear—a trip-motion. Thus, if a piston valve have a diameter of 10 inches, its circumference would comfortably admit of eight wings projecting 3 or 4 inches from the body of the valve, and there would be eight steam ports in the outer shell in which the valve works, each steam port being narrower than the wings by an amount sufficient to provide cover when closed, the space between each port being the same breadth as the wings, so that the ports are fully open in one position of the valve, and fully closed by rotating the valve through an arc of $22\frac{1}{2}$ degrees, or $\frac{360}{2N}$; N being the number of wings allotted to the valve.

These valves have the usual to-and-fro movement of the slide valve, and admit of being designed to give the best arrangement of exhaust, with power to continue steam admission to $\frac{3}{4}$ or $\frac{7}{8}$ths of the stroke, if desired. They have also the axial rotative movement which places the wings opposite a blank or a port. The effect of this is simply to add to the steam lap an amount equal to the length of the wings, and the rotation may take place at any time or any portion of the stroke, and be employed, even, to stop the engine, for, when the wings oppose the ports, there is no steam edge opening at any part of the valve travel. We have known these valves to work and remain perfectly steam-tight for 16 years, and this is no doubt due to the double movement of sliding and rotation; the latter, in an automatically-controlled engine, probably not occurring at exactly the same portion of the travel any two consecutive times.

It is usual to admit steam between the two valves, thereby preserving the valve spindle in tension between them, exhaust taking place beyond the ends. Beyond the friction of the valves, in their seats, produced by the springs which keep the requisite pressure between the two surfaces, there is no resistance to the valve movement. There is no friction, as in a flat slide, produced by steam load, for the only effect of steam pressure on the valves is to produce the valve spindle tension, both valves being of equal diameter, and balancing each other, being exposed on one end to steam pressure, and on the other to the same condenser. A child can move them under full steam pressure.

The chief and, to our mind, the only really serious objection to piston valves is the absolute block they afford against water in the cylinder. When piston valves are used, there must be water relief valves, or the engine will be smashed, to a certainty, should water ever accumulate in larger quantity than will fill the clearance volume.

It appears to us that, in designing piston valves, there has been too great an endeavour made to give them large powers of expansion, as though there would be a great wear of the valve and its seating. Now it is known that in a well-designed shaft bearing there is very little wear, and even flat slide valves frequently show small wear; but piston valves

properly designed have almost no wear at all, and beyond calling for a slight power of expansion, much need not be done to allow for wear. In striving after what is only a fancied necessity, piston valves have been made with narrow rings, and the fancied necessity has become a real one; but the means to meet the demand have been insufficient. Rings are out of place in a piston valve which has to work in a shell that must perforce contain holes cut through it. The edges of the ports cannot be passed by such rings, and the only remedy is to make the whole superficies of the valve continuous, and without any transverse break, merely employing one longitudinal division for elasticity. It is also of paramount importance that a piston valve shall never work in any shell or seating of so great a length as to prevent the valve ends travelling slightly outside the shells at each end of the movement, so that not the slightest shoulder can be formed by wear. All these points have been very thoroughly thrashed out years ago, and though experience continually suggests improvements in detail of manufacture, there is probably but little reason for the apparently experimental stage of the piston valve as treated by Mr. Smith, or for the statement that piston valves have been tried on locomotives and proved superior. The marvel is that with the opportunities of seeing their behaviour in stationary engines the last 30 or 40 years, there should be to-day the general and widespread ignorance that seems to prevail upon so important a detail. As compared with the Corliss valve, the piston valve is far superior. The Corliss valve is a slide valve with a curved face, and of such form and manner of rotation that its tendency is to wear to a face of smaller radius, whereas the seat on which it slides tends to become of larger radius. The Corliss valve depends also upon its spindle bearings for accurate working, and is, moreover, not a balanced valve. None of these grave faults belong to the piston valve, but it has one objection from which the Corliss valve is free; it occupies more space. In a locomotive it can be applied to outside cylinders by placing it inside the smoke box next the frame, or, American fashion, above the cylinder. In an inside cylinder engine the problem of placing the valve is more difficult, but by no means insurmountable.

For electric engines, of course, there are no difficulties whatever in the placing of piston valves. Usually they are placed on the side of the cylinder, but considerations of water accumulations point to the underside of the cylinder as a suitable location. The trembling of the eccentric rod, so often seen where flat slides are employed, is too obvious a sign of friction to be fairly overlooked, and yet it is neglected. No one ever saw a good piston valve set its eccentric rod in tremor from excessive friction.

It is possible that the first cost of a piston valve may be greater than that of a flat slide, though there is no good reason for this. The piston valve, with the exception of any arrangements for securing elasticity of body, is purely a product of the cheapest form of machine work, both the valve and its shell, and shell seating, being machined to size by either a lathe or a boring machine. For production in quantity, therefore, the piston valve is peculiarly fitted to secure good and cheap work, and as it is best made of cast-iron to work on a cast-iron seating shell, there is no expense for special or gun-metal in its production.

The extremely simple method of securing in one valve all the advantages of a perfect exhaust valve, and of an automatic cut-off, which, unlike the Corliss valve, will operate anywhere, from the first one-thousandth to the last one-thousandth of the stroke, ought to bring the piston valve into more general use. The Corliss valve, it is well known, must cut off early, or not at all; it cannot cut off later than the point of full travel, because its cut off motion is merely a part of its ordinary motion, whereas in the piston valve the two are, as they should be, independent, and yet equally simple, an advantage of great importance, and more especially so with high pressures and compound working.

Junior Engineering Society.—The members of this society on Saturday, 6th inst., are to pay a visit to the gigantic wheel works, West Kensington.

HARMONICS IN ALTERNATING CIRCUITS.

Vol. xi. of the *Transactions* of the American Institute of Electrical Engineers contains a report of the recent experiments of Mr. M. I. Pupin, which come under the title of "Resonance Analysis of Alternating and Polyphase Currents." It is another attempt to trace the analogy between the acoustical theory of Helmholtz, as regards the harmonic tones accompanying the "fundamental," and the electrical phenomena of the presence of E.M.Fs. of higher frequency than the periodicity of the generating dynamo in an alternating circuit. In place of the resonators of Helmholtz, and the sensitive manometric flames of König, the author uses what we may call a "sensitive circuit." It consists of an adjustable inductive coil without iron, formed of a large number of turns of copper wire of about 10 ohms resistance, in circuit with which is a condenser subdivided from ·001 m.f. upwards, and an additional rheostat. An electrostatic voltmeter is connected to the terminals of the condenser. This "sensitive" circuit is put as a shunt to a non-inductive resistance inserted in the circuit to be tested, which in these tests consisted of an alternator in series with the primary of a transformer. Suppose, now, that the self-induction of the "sensitive" circuit is kept constant, and that the capacity of that circuit is gradually increased from zero, a value is at last found at which the capacity and self-induction of the "sensitive" circuit produces resonance with one of the harmonics of the alternations of the current in the main circuit; and when this occurs there will be a corresponding deflection at the voltmeter. In this way, it is claimed, all the harmonics which are present in the current of the main circuit can be detected in the course of a few minutes, and resonance diagrams can be drawn representing the analysis of the whole *clang*. The author agrees with Prof. Ayrton in finding no trace of an *even* harmonic in alternating current waves. Alternators with slotted armatures give waves in which all the *odd* harmonics, up to the harmonic of nine times the frequency, could be determined.

Some interesting results were obtained by varying the resistance of a resonant circuit and tabulating the voltmeter deflections for every particular resistance, and then plotting a curve, taking the resistances for abscissæ and the voltmeter readings for ordinates; the curve is approximately an equilateral hyperbola. These values being found for a mica condenser, the experiment was then repeated, using a condenser of paraffin paper. There is a very obvious difference between the two curves, which the author attributes to "the damping effect due to dielectric viscosity;" we presume he refers to the effect observed by Steinmetz and Arno, which is akin to the property which promotes hysteresis in iron. It was recently pointed out by Mr. Rollo Appleyard that these effects are modified by the change in the resistance which the dielectrics undergo at the successive voltages; and, again, that this change is different for mica and paraffin paper, respectively; it is evident that the discrepancy between the two curves obtained by Mr. Pupin is to be ascribed, in part, to this same cause. At low voltages, and at frequencies of over 100 ~ per second, this difference between the two dielectrics did not manifest itself, and Mr. Pupin observes that the damping effect due to the magnetic viscosity of iron is, similarly, small at low degrees of magnetisation, such, for instance, as would be produced by a telephonic current, and at frequencies which are well within the range of higher telephonic frequencies of, say, 750 periods per second. Electrical resonance thus appears to be a very convenient method for studying the viscosity of iron and of dielectrics.

Some further experiments upon an alternator follow, which seem to show that the distortion of the primary current, which occurs when there is no load in the secondary, is present at *all* loads, and is of practically uniform value; it is due to a harmonic of very small magnitude as compared to the fundamental. This persistence of harmonics at all loads, even when completely hidden by the fundamental wave, holds true also when their origin can be traced to the action of the armature of the generator; as in the case of a machine with a slotted iron-core armature. Under all conditions their value seems to depend upon the mean intensity of magnetisation of the magnetic circuits to which they owe their origin; and, as

far as the experiments go, upon nothing else. Their presence is hidden by the fundamental wave at heavy loads; but, when conditions favour resonance with any one of them, they assert themselves, and do all the mischief they can to the insulation; and they seem to be quite independent of hysteresis.

These experiments have been carried out at Columbia College, where, by the way, they use "*ferric*" inductances, "iron" ones being a little antiquated; this, of course, might lend itself to the various forms ferro-, ferri-, ferrous-, inductances; and we expect to hear of ferric-magnets wound with cupric-wire attracting ferro-filings. At Columbia College they duplicate their "c's" even in "acoustics." Why not "accousticcs" and "Ccolumbia Ccollege?"

NEW PATENTS—1894.

17,668. "Improvements in connecting dry batteries without the aid of either terminals or wires." H. Nehmer, F. Nehmer, and T. A. Reynolds. Dated September 17th.

17,714. "Improvements in furnaces for steam-boilers and other purposes." H. Lutz and W. Schaefer. Dated September 18th. (*Complete.*)

17,715. "Improvements in grates or fuel supports for furnaces and the like." A. G. Brookes. (Communicated by E. Fales, United States.) Dated September 18th. (*Complete.*)

17,722. "Useful improvements in the construction of steam, gas, oil, or hydraulic motive-power engines." S. H. Berry. Dated September 18th.

17,728. "Devices for retarding the motion of electrically propelled vehicles." E. A. Sperry. Dated September 18th. (*Complete.*)

17,737. "Improvements in or relating to the manufacture and insulation of electric cables." G. H. Nisbett. Dated September 18th.

17,741. "Improvements in or relating to galvanic batteries." W. P. Thompson. (Communicated by A. Lessing, Germany.) Dated September 18th.

17,761. "Improvements in electric arc lamps." J. Brockie. Dated September 18th.

17,765. "Improvements in gas engines." Tangyes, Limited, and A. J. Lester. Dated September 18th.

17,771. "Improvements in generating steam and in gas producers for this and other uses." W. Felton. Dated September 18th.

17,774. "Improvements in electrical signalling apparatus." The Phonopore Company, Limited, and E. W. Smith. Dated September 18th.

17,789. "Improved driving-gear for actuating dynamo-electric machines." G. Twigden. Dated September 19th.

17,808. "Improvements in electric arc-lamps." H. Lyon. Dated September 19th.

17,820. "An improved solder for soldering aluminium, aluminium alloys, and other metals." W. P. Thompson. (Communicated by O. Nicolai, Germany.) Dated September 19th.

17,845. "Improvements in electric arc lamps." J. Devonshire. (Communicated by E. Thomson, United States.) Dated September 19th. (*Complete.*)

17,846. "Improvements in electric arc lamps." J. Devonshire. (Communicated by E. Thomson, United States.) Dated September 19th. (*Complete.*)

17,873. "Dowson gas enricher." H. T. Blake. Dated September 20th.

17,890. "Improvements in apparatus for governing or regulating the speed of steam and other motive power engines and other machinery." D. Parry. Dated September 20th.

17,922. "Improvements in electric arc lamps." M. Immler. Dated September 20th.

17,968. "Improvements in supporting-insulators for electric wires." L. S. Beardsley. Dated September 21st.

18,032. "Improvements in electric stop motions for machines for preparing and spinning fibrous materials." E. Tweedale, S. Tweedale, and J. Smalley. Dated September 22nd.

18,057. "An improved carbon regulator for arc lamps." L. Zausmer. Dated September 22nd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

6,751. "Improvements in the extraction of chromium by electrolysis, applicable also to the production of chromium alloys." E. Placet and J. Bonnet. Dated March 30th. The inventors take 10 to 15 grains of bi-sulphate of potash, 100 grains of chrome alum, 100 grains of water. They heat until the salts are dissolved, and cause an electric current to pass through the same. The chromium deposits immediately at the negative pole. They keep up the strength of the bath by means of chrome alum alone, or by means of a concentrated solution of chrome alum and alkaline bi-sulphate. 3 claims.

7,806. "Improvements in portable telephonic apparatus." G. L. Anders and W. Kottgen. Dated April 18th. The object of the invention is to provide a portable micro-telephone consisting of a case containing the microphone and receiver, to which is attached an elongated mouthpiece forming the handle of this portable telephone. A portion of the mouth-piece is formed of a hollow soft-iron tube through which the sound waves pass, and which constitutes the inducing core of the induction coil. 2 claims.

12,257. "Improvements in electricity meters." G. Binswanger and H. J. Coates. Dated June 22nd. The invention is designed to obviate the necessity of dismounting the pendulums in any form of electric meter in which pendulums are used. 4 claims.

12,516. "An improved loud-speaking telephone and circuits for same." A. Graham. Dated June 26th. The apparatus consists of a transmitter and galvanic battery at one end of the line in the same and direct circuit with the line wire and a telephone receiver at the distant end of this same line. In order to get the reverse action the inventor uses another set of apparatus with another separate line in direct circuit, merely reversing the positions of transmitter with battery and telephone receiver. 7 claims.

13,518. "Improvement in gas and vapour motor engines and the like." A. Fiddes and F. A. Fiddes. Dated July 12th. Has for its object to increase the power of the engine or lessen the consumption of gas by causing a cleansing charge of air to pass through the working end of the cylinder at the same time the engine is exhausting and causing another charge of air to pass in the working end of the cylinder the same time the engine is compressing the combustible charge and in what manner the same can be performed and worked. 4 claims.

14,664. "Improvements in electromotors for alternating currents." J. A. Kingdon. Dated July 31st. The inventor constructs the commutator of the motor with thick plates or pieces of mica or other insulator between the bars or segments. A group of several brushes is arranged to make contact on one or more adjacent bars of the commutator and a similar group of an equal number of brushes is arranged to make contact on the opposite bars of the commutator. The brushes are insulated from one another and are thinner than the insulating material between the commutator bars, so that a pair of adjacent commutator bars cannot be short circuited by a brush. The brushes of each group may be arranged side by side or one behind the other so that they make contact with the commutator bars in succession. 7 claims.

14,953. "Improvements in regulating the supply of electricity to incandescent lamps." T. B. Sharp. Dated August 4th. Consists in placing a rapid make and break arrangement in the circuit in which the lamp is. 2 claims.

15,610. "Improvements in apparatus for the electrolytical decomposition of brine and other liquids." F. G. Baily and M. Guthrie. Dated August 17th. Claims:—1. In apparatus for the electrolytical decomposition of brine and other liquids, feeding the said liquid or electrolyte into the electrolysing vessel at points between the electrodes, separating the latter from the inlet or inlets by screens or diaphragms of porous or perforated material through which the fresh liquid or electrolyte is caused to flow in opposite directions from the central portion of the said vessel towards the electrodes, and drawing off electrolyte or modified liquid from points near to or behind the electrodes, substantially as described. 2. Apparatus for the electrolytical decomposition of brine and other liquids constructed, arranged, and operating substantially as hereinbefore described with reference to the several examples illustrated.

15,736. "Improvements in and relating to machinery for covering telegraph, telephone, and electric cables and wires with lead or metallic compounds, also applicable for the manufacture of metallic pipes and the like." G. Edward and T. Edward. Dated August 19th. Relates to machinery, of the lead press type, for covering telegraph, telephone, and electric wires or cables with lead or suitable metallic compounds. 5 claims.

15,781. "An improved system of electric wiring." T. P. Rennoldson. Dated August 21st. The positive and negative wires are fixed parallel to each other and tightened mechanically by screws or other appliances so that any slack may at any time be taken up. These wires are supported at intervals by porcelain (or other insulating material) pieces fixed in a suitable bracket. 2 claims.

16,017. "Improvements in electrically actuated machine tools." H. W. Gibbs and G. J. Gibbs. Dated August 24th. The inventor combines in one casting the spindle case of the machine tool and a portion of the field magnet of the electromotor, whereby a convenient arrangement of mechanism is attained with less weight and cost than in similar machines as heretofore constructed. 6 claims.

16,026. "An automatic regulator for dynamo-electric machines." Siemens Bros. & Co., Ltd., and E. Holmes. Dated August 24th. Claim:—An automatic regulator for a dynamo-electric machine, wherein a solenoid having its coil traversed by the current generated by the dynamo, by more or less attracting its core, as the current varies causes a pawl collar on a vertically reciprocating rod to move the one or the other of a pair of ratchet wheels geared to a ring carrying the brush frame of the commutator, the brushes being thus moved more or less towards or away from the neutral line for their contact, substantially as described with reference to the drawings.

16,411. "Improvements in gas engines." C. N. Garner and J. V. Sherrin. Dated August 31st. Refers to gas engines in which an explosion is obtained in the cylinder at every revolution.